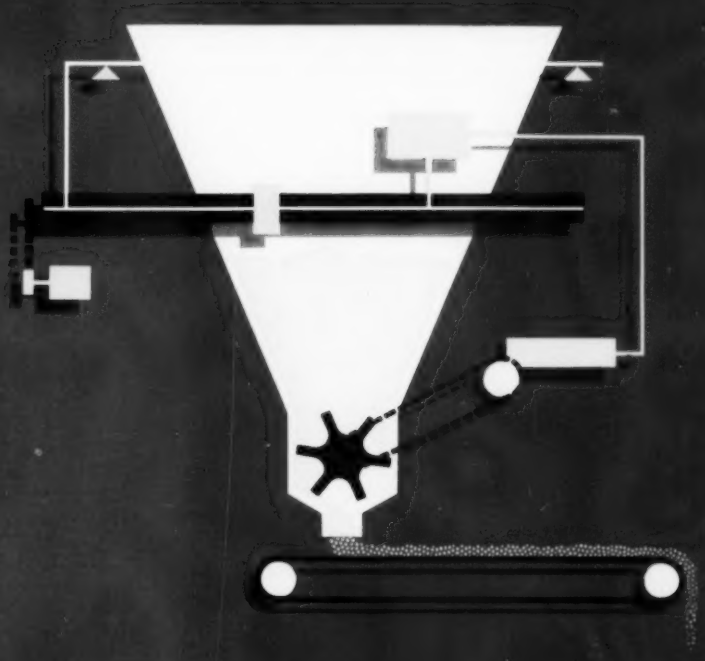
# AUTOMATION

MAY 1960



# *Dispensing Problem Materials*

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS


- A Look Into Tomorrow
- Parts Handling System
- Temperature Measuring Devices
- Using Pressure Switches

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A PENTON PUBLICATION

Vaughn Haynes, right, manager of production engineering, discusses "trap" line scheduling with Wilfred Pascoe, superintendent of press room.

# Chrysler blanks strip steel by "trap" shearing on Wean coil processing line

Trapezoidal shearing from coil is, in many cases, the most economical way to prepare blanks for subsequent press operations. Two, independent, pivoting shear heads allow selection of the most economical proportions of the blanks for the finished shapes. This "tailoring" of the material to the end parts eliminates much of the material loss that would result if these same parts were stamped and drawn from square-cut sheets.

Wean has designed and built almost all of the "trap" shear lines used today. The installation shown is at Chrysler Corporation's mammoth Twinsburg, Ohio stamping plant. This Wean coil processing line incorporates strip cleaning, flexing, leveling and shearing operations that turn as-received mill coil into sheet, ready for press work.

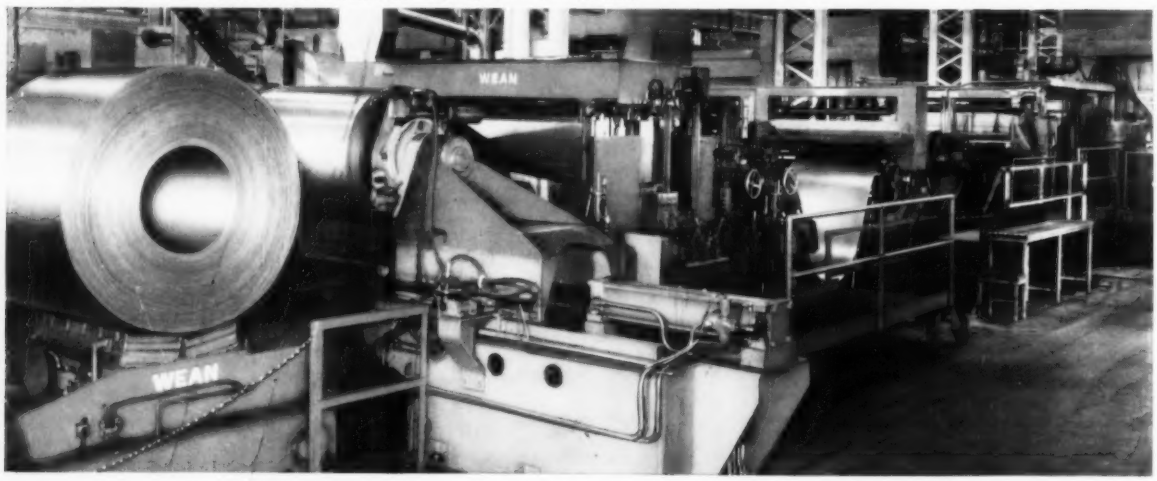
Today, more and more alert metalworking firms are turning to coil processing as one of the answers to rising production costs. If your firm uses approximately 500 tons/month of flat-rolled steel, you may be missing major material and overhead savings if you still purchase in sheet form.

An experienced Wean representative will be able to tell you, or your production executives, if coil processing can cut your costs—and how much. Many firms have amortized the equipment costs involved within one year.

WEAN EQUIPMENT CORPORATION
CLEVELAND 17, OHIO

**WEAN**

Wean trapezoidal shearing line at Chrysler's Twinsburg Stamping Division plant produces blanks for body stampings from coils weighing up to 30,000 pounds.

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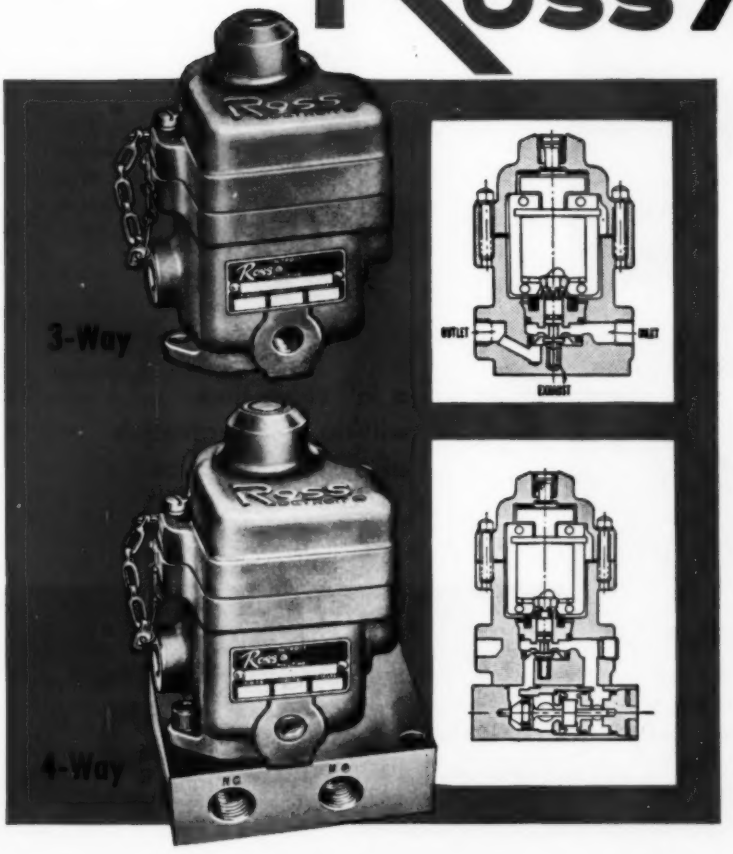
# Announcing

## *a new and better solenoid valve in the $\frac{1}{8}$" and $\frac{1}{4}$" size range*

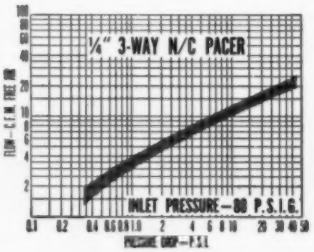
# Ross *PACER*



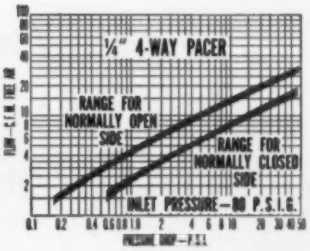

## More life
## More speed
## More capacity
## More value

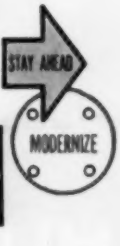
Now you can have about three times more flow capacity-to-solenoid size than in most competitive valves. Needs just 7 watts of power yet minimum internal orifice size is full $\frac{1}{4}$". The PACER has short poppet travel, will cycle at better than 1000 cpm and meets JIC specifications. Lightweight, cast aluminum body means 3-way weighs just 20 ounces, 4-way just 28. Dust tight, liquid tight, can be manually actuated, has captive cover, is inoperative with cover removed, has integral wiring space. Why not test a PACER in your own circuit, just $18 for a 3-way, $26 for a PACER 4-way. Call your Ross representative or write for Bulletin 319.

Pressure drop thru 3-way N.C. Pacer valve under steady flow conditions. Inlet pressure 80 psig. Data shown as a range rather than as absolute values due to variables such as barometric pressure, manufacturing tolerances, etc.




Pressure drop thru both N.C. & N.O. sides of 4-way Pacer valve under steady flow conditions. Inlet pressure 80 psig. Data shows ranges for each side rather than absolute values due to variables such as barometric pressure, manufacturing tolerances, etc.




**ROSS OPERATING VALVE COMPANY**

131 EAST GOLDEN GATE AVE. • DETROIT 3, MICH.



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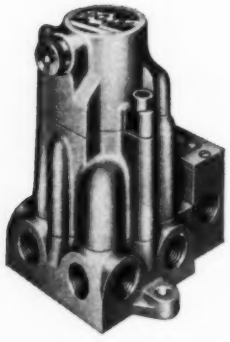
# Compare what the **PDQ WILL DO...**
# Compare the **PDQ PRICE...**
## *With any other air valve...*



**a ½" valve that will do a ¾" valve job at a ⅜" valve price**

- ☑ Accessibility
- ☑ Simplicity
- ☑ Speed and Capacity
- ☑ Price and Quality

What will the PDQ do? It will do a ¾" valve job. It has faster response time and greater capacity than valves twice its size and four times its weight. To repack you simply replace 2 self-contained units in less than a minute. You can change valves on the line in less than 30 seconds.

Will the PDQ last? The PDQ has a short stroke, and a light but rugged aluminum construction with built-in wear compensation. Anticipated valve life is conservatively estimated at 35 million cycles . . . on most applications this is **years** of trouble-free service. Coil (properly applied) is unconditionally guaranteed for the life of the valve.

How about the price? The PDQ is a ½" valve at a ⅜" valve price. Write us today.

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MAY 1960
Vol. 7—No. 5

# AUTOMATION®

A PENTON PUBLICATION

*The Magazine of Automatic Manufacturing Operations*

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# automation outlook

**BENEFITS FROM INVESTMENT**

" . . . It can be shown that for every $1000 invested in capital equipment here in the United States, $350 is added to the national income. . . . Twenty dollars of it goes for local real-estate taxes, $50 of it goes to the Federal Government in corporate income taxes, $60 of it is interest or dividends and goes to those who saved up and invested the original $1000 of capital, and the remainder, $220, goes to labor as increased wages. . . ." *—J. Harrington Jr., head, Mechanical Engineering Div., Arthur D. Little Inc.,* *see page 66.*

**KEEPING EQUIPMENT MODERN**

" . . . one way for American industry to keep ahead of foreign competition is to maintain the most modern production equipment—and American industry cannot afford to continually invest in the most modern equipment without at least as good charge-off opportunities as are enjoyed by Europe. . . . "*—N. M. Forsythe, National Automatic Tool Co. Inc.*

**PRODUCTIVITY NOT OUTPUT PER MANHOUR**

" . . . Productivity is not, by any means limited to output per manhour. In any one company or industry, for example, an increase in output per manhour may be completely offset—or even outweighed—by the increased cost of machines or materials that made the higher output possible. Thus, a company conceivably could obtain greater output per manhour and reduced productive efficiency at one and the same time. Productivity, as I shall use the term, is synonymous with productive efficiency—the ratio of output to all the varying inputs—time, labor, materials, machinery, and investment. . . . "*—C. T. Zimmerman, staff engineer—automation, American Steel & Wire Div., United States Steel Corp.*

**SHEDDING PAPERWORK SHACKLES**

" . . . New scientific advances [in data processing] offer us the opportunity of considering a major change in business administration and management. The full utilization of these new resources can be achieved not by substituting them for functional efforts but by taking the major step of making them the heart of business control. This step is not easy and must come gradually, but it holds the promise of freeing business from the bonds of paperwork and offering new opportunities of growth and profit for American business. . . . "*—T. A. Smith, executive vice president, Industrial Electronic Products, Radio Corp. of America.*

**MEN FOR MAINTENANCE**

" . . . The proportion of maintenance workers to total workers is rising and will have to increase drastically in the years ahead. The proportion of highly trained men among them will rise too. For computers and programming control systems there is a need for a trained engineer-technician as trouble shooter and repair man. He may merely locate a faulty sealed component, a 'black box,' and replace it with a new one. But he must be well trained in the design of the control system and understand its importance and timeliness to the productive process. . . ."*—J. J. Durkin, general manager, Service Shops Dept., General Electric Co.*


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# . . . Fluid Power news

REPORT NO. 11,701 SERVO-CONTROLLED MOBILE DRILLING BARGE

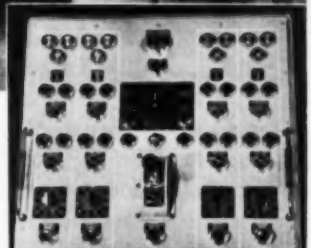
From Oilgear Application-Engineering* Files

## HOW OILGEAR Æ* SOLVED THE "CONTROL AND MUSCLE" PROBLEMS ON MR. GUS II

**OWNER:** C. G. Glasscock Drilling Co., Corpus Christi, Texas
(Built by Bethlehem Steel Company Shipbuilding Division, Beaumont, Texas)

**DATA:** System design and equipment for a 9,000-ton mobile oil drilling barge. Barge platform is large enough for 28 bowling alleys on each of its three decks (173′ x 104′ x 22½′) — allowing ample room for spectators . . . will accommodate personnel and all equipment for complete offshore drilling operation.

**REQUIREMENTS:** 1: Operation to be selected from central control room: (1a) remote automatic, (1b) remote semi-automatic, (1c) manually controlled at each station. 2: Accurate, automatic synchronization and visual indication during lifting and lowering operations to insure keeping platform level. 3: Power selection and control from remote control room for: (a) four anchor winches, (b) four 10′ dia. by 235′ long caissons which raise the platform up to 50′ above the surface of water 150′ deep. 4: Individual, local control for: (a) moving drilling derrick bridge to and from drilling position, (b) driving four 7′ dia. by 130′ long steel pilings 40′ to 65′ into Gulf bottom. 5: Must be quiet, dependable, vibration and trouble-free.



**LEFT:** Mr. Gus II operating in 137 ft of water. With full equipment as shown, "Gus" grosses over 9,000 tons. At previous location in 80-ft water depth, "Gus" was undamaged by hurricanes Bertha and Esther. **ABOVE:** Operational "nerve" center for Fluid Powered operations. Oilgear servocontrolled indicators above the Oilgear control console show positions of each of four caisson jacking-yokes within ±⅛". Control panel of console is shown in insert. These controls can be used for complete automatic, semi-automatic, or individual control.

**SOLUTION:** An Oilgear Application-Engineered *electro-feed-back-hydraulic-servocontrol and indication system*, built by The Servocontrol Division of Oilgear, for accurate remote and local control over the Oilgear Application-Engineered Fluid Power systems. Automatic synchronization during lifting and lowering — by electrical comparison and compensation is so accurate that if platform tilt exceeds 1/30th of a degree of arc, operation shuts down automatically. Two Oilgear Heavy-Duty "Power-Paks" using type "DY," two-way, variable displacement pumps with servo-motor and hydraulic amplifier controls power each of the four caissons and anchor winches. Compact, plug-in, hand pendant, servocontrols are provided for local, manual operation. Two heavy-duty "Power-Paks" using type "DH," two-way, variable displacement pumps with servo-motor lever control inside each caisson smoothly drive the steel pilings, "locking" the barge to the Gulf bottom. The drilling derrick is moved from drilling to transport position by a similar pair of "Power-Paks" with type "DH" pumps.

**OWNER REPORTS** — *"In addition to setting a world record as far as water depth location, Mr. Gus II performed satisfactorily in setting the well protective structure — something that no other rig in the world can attempt to do . . . the most outstanding offshore rig yet designed and built . . . no trouble at all with the equipment you (Oilgear) built . . . you have certainly created a fine piece of machinery."*

A detailed, 12-page operating description of Mr. Gus II is available from Oilgear. Request Fluid Power News 6.

The large drilling barge "S-66" being built by Avondale Marine Ways, Inc., New Orleans, La., will be similarly Oilgear-equipped . . . as will "Mr. Louis I," a huge, 12-caisson drilling barge being built by Universal Drilling Co., Inc.

Other Oilgear marine applications include power and control systems for steering and flanking gear, elevators, catapults, hoists, winches, large valve controls, lock and dam gates.

***Users in ALL industry agree that . . .***
***. . . for the lowest cost per year — it's Oilgear!***

*For similar practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .*


**THE OILGEAR COMPANY**
*Application-Engineered Controlled Motion Systems*
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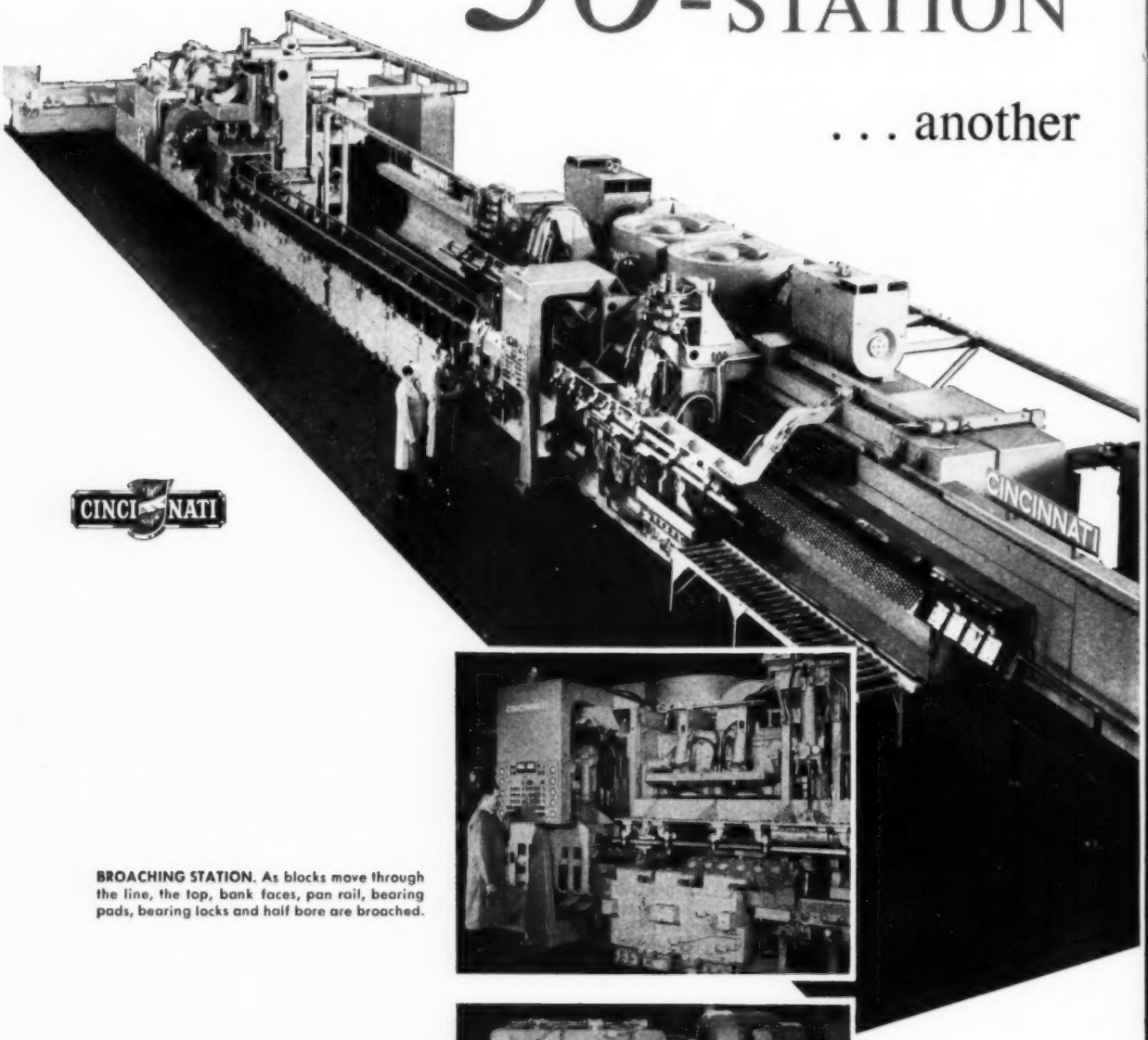
# 36-STATION

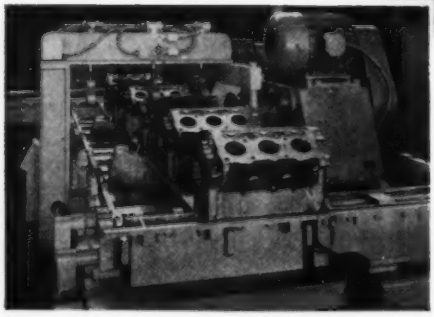
## . . . another




CINCINNATI



**BROACHING STATION.** As blocks move through the line, the top, bank faces, pan rail, bearing pads, bearing locks and half bore are broached.



**MILLING STATION.** Pads are milled on the side of the block, and the front and rear ends are rough and finish milled. Front of block is being milled in this photograph.

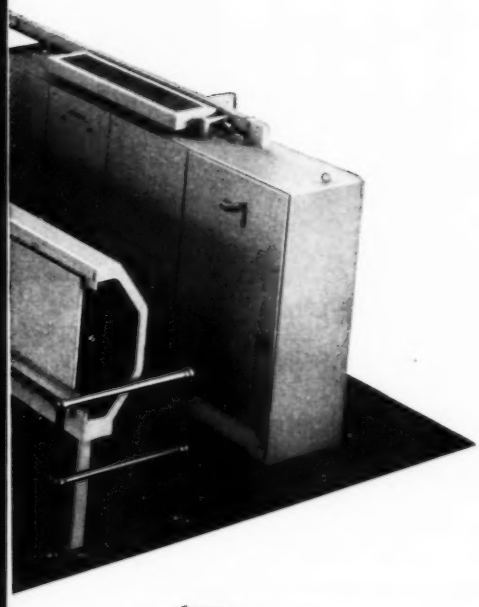
DESIGNERS AND BUILDERS OF SPECIAL MACHINES • VERTICAL AND HORIZONTAL BROACHING

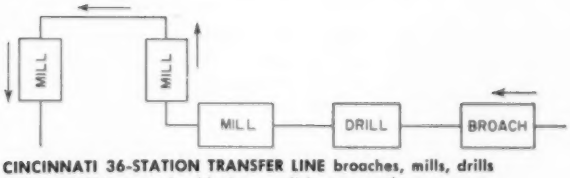
THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

# TRANSFER LINE

## example of *Dependable Productivity* from

## CINCINNATI | SPECIAL MACHINE DIVISION






**CINCINNATI 36-STATION TRANSFER LINE** broaches, mills, drills and reams V-type engine blocks . . . all in one continuous operation. Production—67 per 60 minute/hour.

In this special 36-station transfer line, the world's largest horizontal broaching machine is integrated with drilling and milling stations . . . for continuous, automatic machining of V-type automotive engine blocks. Cincinnati's Special Machine Division designed, built and assumed full responsibility for every detail of the line.

Twelve surfaces are machined on the broach, which has a 600 hp drive capable of developing a broaching force of 100 tons! Manufacturing holes then are drilled and reamed, and 10 surfaces milled, all in one continuous automatic operation. The line measures approximately 140 feet, and uses 30 motors capable of producing more than 1000 hp. Its design is such that three different bore sizes may be accommodated with very little change-over.

From the first broaching operation to the final interlock station, this giant production line is evidence of the capabilities of the Special Machine Division. In addition to over 45 years' experience in designing and building special machinery, Cincinnati offers the most extensive research and development, foundry and shop facilities in the machine tool industry. And you will be pleased with Cincinnati's follow-up service to assure dependability of performance. Our Field Engineers will be glad to give you an analysis of what the Special Machine Division can do for you.

MMT-PE

MACHINES • COMPLETELY AUTOMATED PRODUCTION LINES

**CINCINNATI®**
SPECIAL MACHINE DIVISION

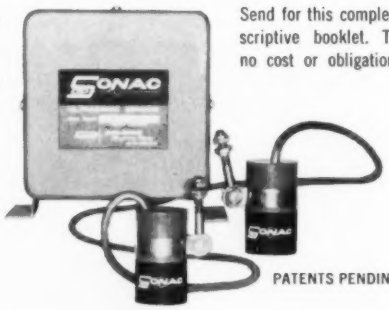


Circle 657 on Page 19

A NEW, ULTRA-SONIC, NON-CONTACT SENSING AND SWITCHING SYSTEM

SONAC

Here truly is a new dimension in automated controls! Delavan's new SONAC uses ultrasonic energy for its "beam". This new concept offers many advantages over available sensing devices. SONAC has no lamps to burn out . . . nothing to replace . . . eliminates down time. SONAC is unaffected by vibration, dust, industrial contamination or ambient light. SONAC will sense ferrous and non-ferrous metals, liquids or solids, transparent or opaque materials, yet requires less power than an ordinary flashlight. These are a few of SONAC's advantages.

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*Manufacturing Company*
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Circle 658 on Page 19

# AUTOMATION news

Today's events and developments in the field of automation

## Special Equipment Improves Relay Component Manufacture

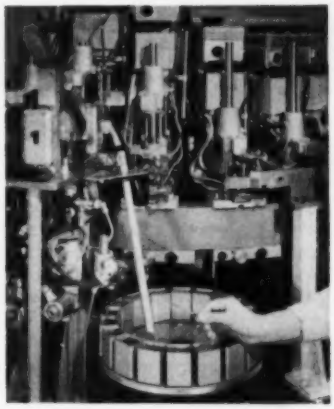
ECONOMICAL assembly of sealed contacted reed switch capsules for relays is carried out in a special manufacturing area recently added to the C. P. Clare & Co. relay plant in Chicago. A feature of the new facility is an automatic, 18-station assembly machine for making the capsules. This machine is operated in a rigidly controlled atmosphere so as to prevent contact contamination.

A sealed contact reed switch capsule (see photo) includes a pair of nickel-iron alloy reeds having gold plated contact surfaces. The shaft of each reed is fused to one end of a glass capsule so that opposing contact surfaces are facing one another inside the capsule. The atmosphere inside the capsule is an inert gas, and the reeds are positioned to extremely close tolerances so as to ensure uniform mechanical and electrical properties. The contacts are operated magnetically by an external coil or magnet.

Operations performed automatically by the capsule assembly machine include feeding the reeds and glass tubes from magazines, positioning the parts, replacing the air in the tubes with an inert gas, and fusing the ends of the glass tubes

to the shafts of the reeds. Recording and control equipment associated with the assembly machine is used to control the inert gas mixture.

An interesting feature of the assembly machine is the manner of collecting completed switch capsules so as to facilitate quality control.



AUTOMATIC, 18-station assembly machine produces sealed contact reed switch capsules for use in relays. Functions performed by the machine include feeding of parts from magazines, assembling, inert gas filling, and heat fusing. As shown in the close-up, completed assemblies are dropped through a tube into receiving cups associated with each station. If trouble develops in a given station, all of the products from that station will be found in the corresponding cup. Special precautions are taken to exclude dust from the area in which the assembly machine is operated.

An individual receiving cup associated with each of the 18 stations of the machine rotates in synchronism with its station. When a station passes a discharge point, a finished assembly drops through a tube into the cup for that station. Inspectors can then sample the product from any station by taking parts from its cup. If the parts fail inspection, all the products from that station will have been segregated in the cup.

Elaborate precautions are taken to prevent contamination of the switch contacts during assembly. For example, the air supply in the assembly area is double filtered—first through an electronic prefilter and then through an absolute filter—so that no dust particle greater than 0.3 micron in diameter may pass.

Employees entering the assembly area must follow a special procedure. They walk first across a metal grill and then over a mechanical shoe cleaner employing rotating nylon brushes. The brushes deposit shoe dust and dirt in a pit under the floor where it is removed by vacuum. Then the employees enter an air lock where they don special outer clothing. After their shoes are cleaned a second time, the employees may enter the assembly area from the air lock.

For further protection against the entry of dust, the assembly area is kept under positive air pressure. An air conditioning system maintains a constant temperature of 75F in the room, and the air is changed completely every three minutes in order to remove process heat.

Sealed contact switch capsules are used as relay elements in several ways. For example, a single capsule may be inserted in a coil and operated magnetically when the coil is energized. A cluster of as many as six capsules may be mounted in a plug-in, tubular container and operated by a single magnetic coil. Other arrangements include multiple capsules and coils

mounted on a printed circuit board or in a flat, rectangular container.

A relay using a single capsule and coil may be operated in as little as 0.8 millisecond and released in 0.25 millisecond. Coil power can be as low as 0.25 watt. Suitable for automatic control, data processing, and computer applications, the capsules have excellent shock and vibration resistance. Life expectancies of over 100 million operations are possible.

## MEC Holds First Annual Meeting At Purdue University

NEWLY formed Manufacturing Engineering Council (see AUTOMATION, Feb. 1960, p. 21) held its first annual meeting at the conclusion of the recent Fourth Conference on Manufacturing Automation at Purdue University, Lafayette, Ind. Purpose of the meeting was to receive new members and provide additional details to those interested in the activities of the Council.

At the Conference banquet, **F. I. Ellin,** chief production engineer, Ohmite Mfg. Co., and president of MEC, addressed the conferees. In his talk, Mr. Ellin pointed out that the manufacturing engineer is a new species of engineer who is equipped to take a lead in every manufacturing enterprise to produce the best product at the lowest possible cost. Success in this endeavor, according to Ellin, requires personnel who are well versed in technical disciplines — electrical, mechanical, hydraulics, chemical, and industrial engineering—as well as economics and human engineering. The new organization, he said, is dedicated to serving the needs of such a group.

A four-point Council program was

## *Fourth Conference on Manufacturing Automation*

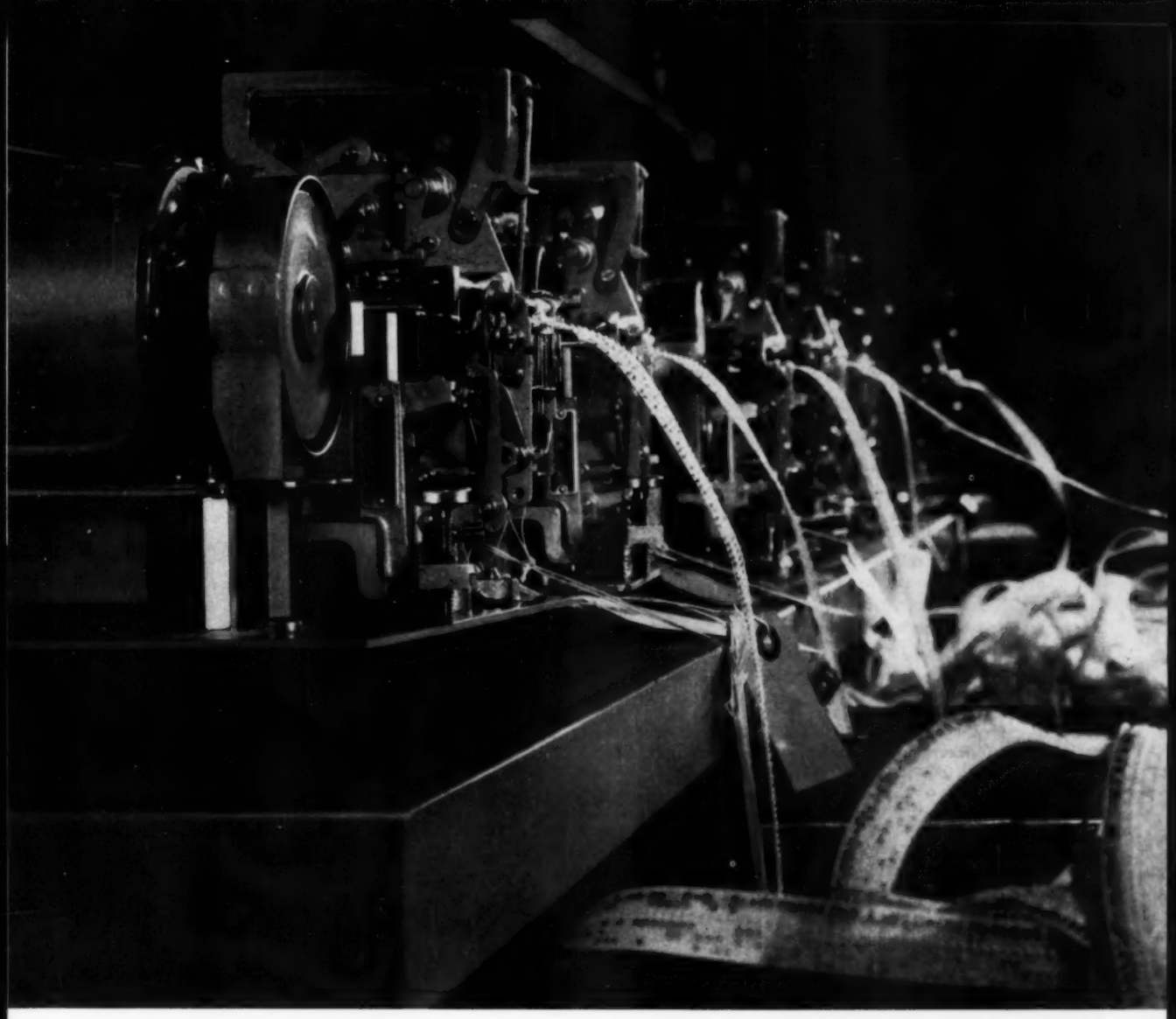
CONTINUING a tradition of success with past conferences of its type, the Fourth Conference on Manufacturing Automation was held at Purdue University, Lafayette, Ind., during April. The event was co-sponsored by Purdue's Schools of Mechanical and Industrial Engineering, the Manufacturing Engineering Council, and AUTOMATION magazine. Built around a framework of technical papers covering fundamentals and practical aspects of industrial automation, the program also featured informal discussion sessions at which automation authorities were available to answer questions of direct interest to conferees. Always popular, the informal sessions permitted man-to-man detail discussions of specific and varied aspects of the field that could not be covered in the formal program. Other activities scheduled during the three-day event included luncheon and banquet talks and special sessions where automation films and exhibits were shown.

Designed for top management and manufacturing engineers who plan, design, and install automated systems for industry, the conference program reflected the basic interests and needs expressed by those attending previous conferences. In five formal sessions, the well-rounded program covered organization and costs, automatic processes, handling in process, and control of operations. At the conclusion of the conference, officers of the Manufacturing Engineering Council met to conduct business and greet new members and others interested in Council activities.

Keynote of the conference was sounded by J. Harrington Jr., banquet speaker, who said, "If we are going to hold to our present increasing standard of living, we shall have to automate to the limit of our ability."

CONFERENCE personalities who addressed attendees at various times included (left to right): R. W. Bolz, editor, AUTOMATION magazine; F. I. Ellin, president, Manufacturing Engineering Council and chief production engineer, Ohmite Mfg. Co.; H. T. Amrine, professor and head, School of Industrial Engineering, Purdue University; and J. Harrington Jr., head, Mechanical Engineering Section, Arthur D. Little Inc.

FIRST session of the Fourth Conference on Manufacturing Automation brought together special machine buyers (left) and sellers (right) to discuss their viewpoints on *Engineering Costs—Who Pays?* After each panel member had presented his thoughts on equitable arrangements for transacting business in this market, the session was thrown open for questions and comments from the audience. James C. Keebler, managing editor of AUTOMATION (in background of righthand photo), was panel moderator of this opening conference session.



# *Continuous operation— a Teletype equipment tradition*

All Teletype equipment . . . like the tape punches being final-tested above . . . are subjected to a rigorous quality-control program to insure that the units will give continuous, day-in, day-out performance in your service. Such performance is a Teletype tradition, established during more than fifty years of manufacturing data communications equipment.

To maintain this performance tradition requires much more than testing, however rigorous. It begins with the very design of the units themselves—the product of extensive research and development facilities, backed by cumulative experience. And it involves precision manufacture—employing the latest technological advances, from highly specialized machine tools and automated processes to electronic measuring and sensing devices.

When you select Teletype equipment to speed your communications and cut your paperwork costs, you can be sure of built-in quality. Teletype Corporation manufactures this equipment for the Bell System and others who require the utmost reliability from their data communications systems.

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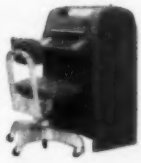
Typing Tape Punch

Tape Reader



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Whether the Vickers power package you choose is standard or custom engineered, you save money and time because it comes *ready-to-go*—designed and assembled to the highest standard of quality by hydraulic specialists.

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**Machinery Hydraulics Division**

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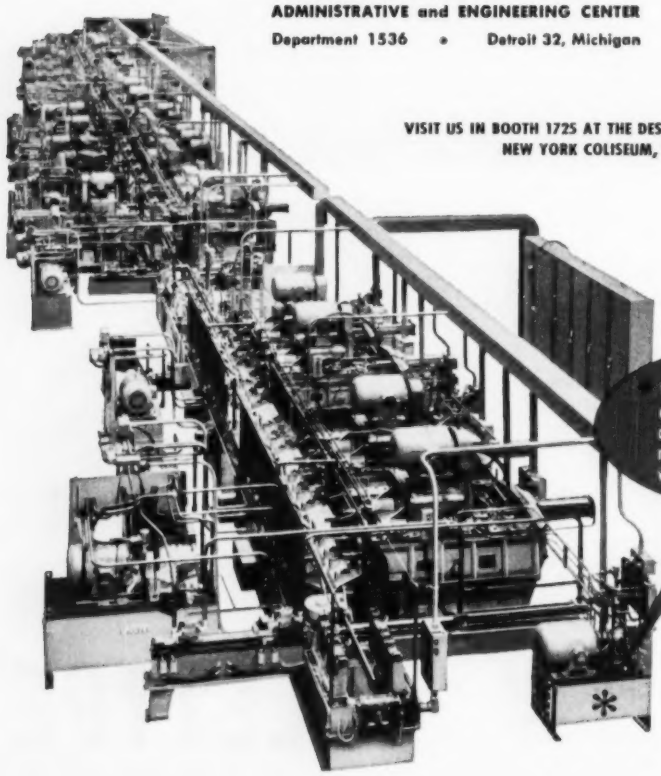
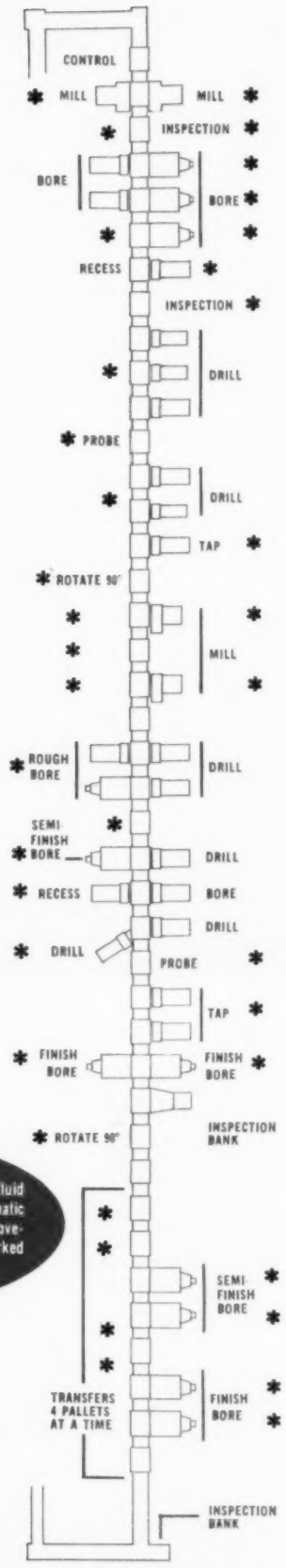





Vickers power packages supply fluid energy for fast, precise, automatic clamping, transfer and head movement at station locations marked with asterisk.

**AUTOMATION NEWS**

announced which includes: 1. The formation of regional chapters where manufacturing engineers can meet to discuss mutual problems. 2. Establishment of a national clearing house for the exchange of information on sources for automatic equipment and components. 3. Fostering of educational programs for the training of manufacturing engineers in colleges and schools. 4. Publication of proceedings, standards, and other data which will benefit industrial applications. Over-all objective of the Council is to elevate manufacturing engineering to its proper status as a profession.

## Increasing Tire Market Prompts Automated Plant

PREPARATIONS for construction of a new, multimillion-dollar tire manufacturing plant near Ft. Wayne, Ind., have been announced by B. F. Goodrich Co. The facility is being built to meet anticipated expansion of the tire market during the next five years and will produce most types and sizes of tires used on passenger cars, trucks, and farm implements.

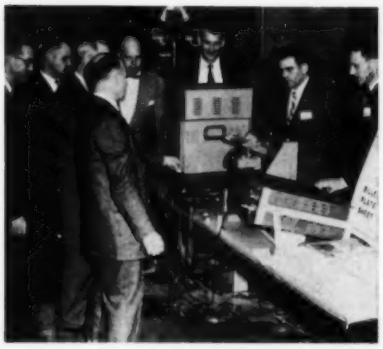
The plant, which has been in the design stage at B. F. Goodrich for more than three years, will include the latest applications of automation developed by the company and others. The plant layout will be straight-line, with raw materials entering at one end of the building and finished products emerging at the other. Quality control methods will be stressed throughout the manufacturing process.

According to **J. W. Keener**, president of B. F. Goodrich, the demand for tires is expected to increase

## *Fourth Conference on Manufacturing Automation*

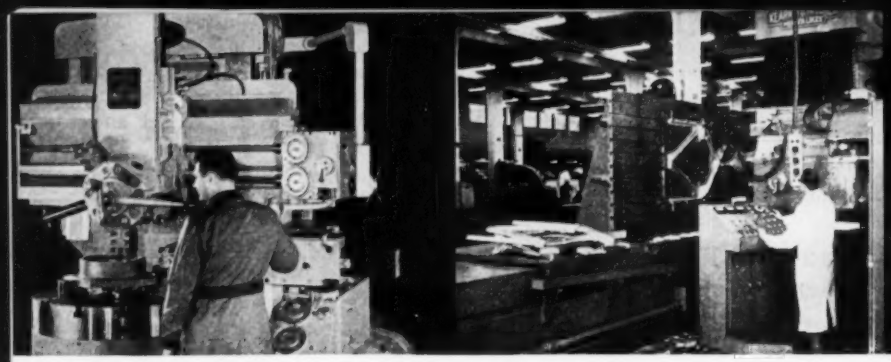
INFORMAL discussion meetings were a highlight of the conference. K. H. Meyer, manager, Manufacturing Services, Reliance Electric & Engineering Co. (standing at left), conducted a session on costs and payoff, subject of his conference presentation.

CONFEREES attending an evening session of automation exhibits and films pause to watch a demonstration of an ultrasonic inspection system developed by Sperry Products Inc.

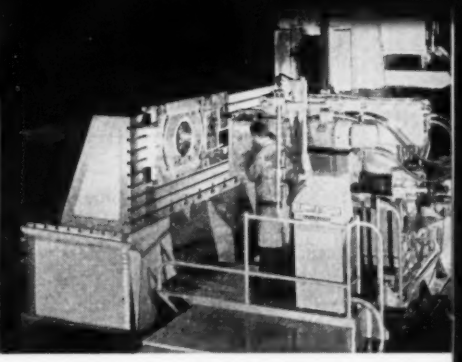


AMONG the permanent exhibits shown to conferees at the Purdue University machine tool laboratory was this working scale model of an automatic transfer line built by National Automatic Tool Co. Inc.

DISCUSSION group led by H. A. Leone, manager, Headquarters Manufacturing Laboratory, Westinghouse Electric Corp., exchanged views and experiences on process analysis and machine procurement.



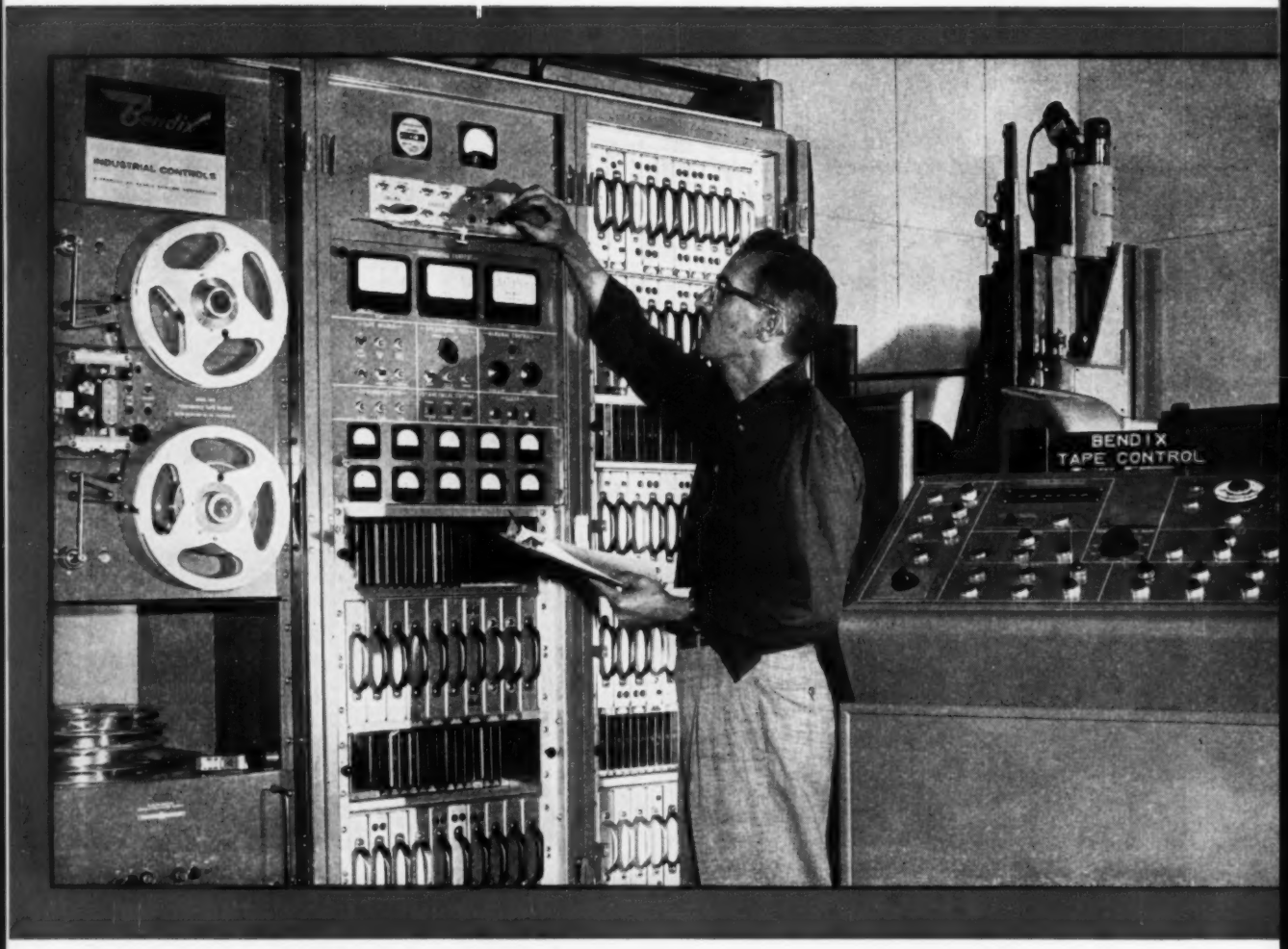
**1** Bullard vertical turret lathe similar to machine now being equipped with numerical controls for use by A.E.C.



**2** Kearney & Trecker 3-axis milling machine in use at The Martin Co., Baltimore Division.

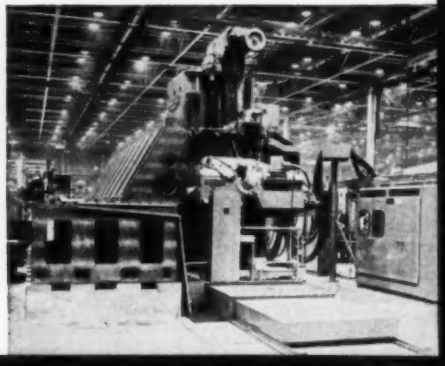


**3** Kearney & Trecker 3-axis A.M.C. profiler in use at Norair Div. of Northrop Corp.




Bendix Continuous Path Machine Control Unit.

**7** Kearney & Trecker 4-axis profiler in use at Columbus Div. of North American Aviation, Inc.



BETTER TOOLS THROUGH TEAMWORK

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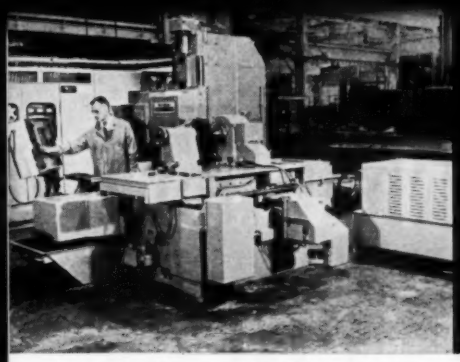
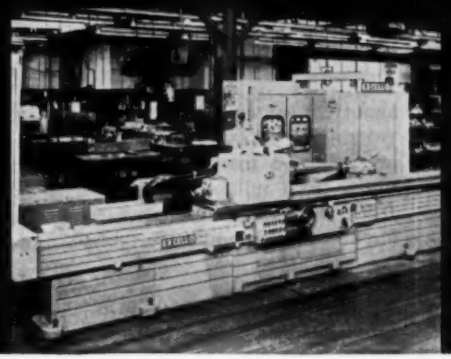
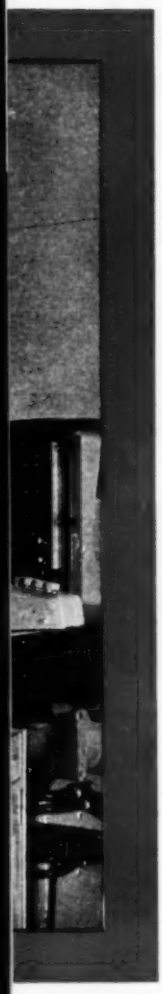


**4** Pratt & Whitney 3 out of 4-axis Numeric-Keller in use at Pratt & Whitney Aircraft Div. of United Aircraft.



**5** Ex-Cell-O rotary profiling machine in use at Ex-Cell-O Corp., Detroit.

**6** Pratt & Whitney 3-axis Numeric-Keller in use at Pratt & Whitney Co.



*TEAM REPORT: Bendix Numerical Controls for Machine Tools*

# MACHINE TOOLS WITH BENDIX NUMERICAL CONTROLS ROLL UP 190,000 PRODUCTION HOURS

***Machine Tool Builders, Bendix, and Machine Tool Users Team Up To Cut Production Costs and Lead Time With Numerical Controls.***

Bendix Continuous Path Numerical Controls have logged more than 190,000 hours (95 work years) of production time on a wide variety of machine tools. The photos and captions on these two pages show a few of the applications of Bendix Numerical Control on machine tools.

Bendix considers numerical control a *Complete* Manufacturing Concept and offers the user and machine tool builder experience in Electronic Data Processing, Electronic Controls and Machine Tool Servo Design. This concept achieves practical reality through the cooperation and teamwork of the machine tool builder, Bendix, and the machine tool user. And Bendix has more working experience in the field of continuous path control with machine tool builders and major users than any other electronic controls manufacturer.

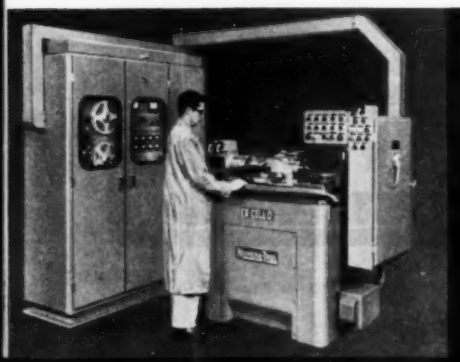
Bendix teamwork experience gives the manufacturer who needs machine tools a marked benefit: it permits him to plan ahead *now* by specifying Bendix Numerical Controls for his machine tools. Regardless of product configuration or machine tool preference, Bendix can deliver numerical controls that have been proved in use.

***Watch for announcement soon on positioning controls by Bendix.***

Industrial Controls Section
21820 Wyoming, Detroit 37, Michigan

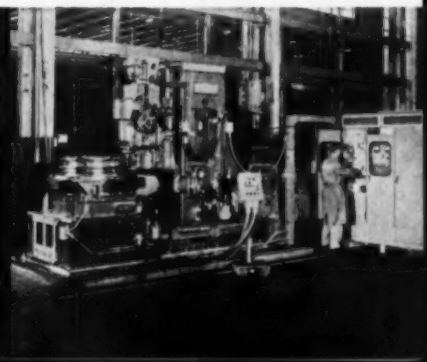
Bendix
AVIATION CORPORATION

**8** Ex-Cell-O cam milling machine in use at Hamilton-Standard Div. of United Aircraft Corp.



**9** Ex-Cell-O Model 922 precision template grinding machine in use at ACF Industries.

**10** Kearney & Trecker 2-axis rotary profiler in use at Pratt & Whitney Aircraft Div. of United Aircraft Corp.



Circle 661 on Page 19

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Eriez Mfg. Co., 119-EA Magnet Drive, Erie, Pa.

ERIEZ

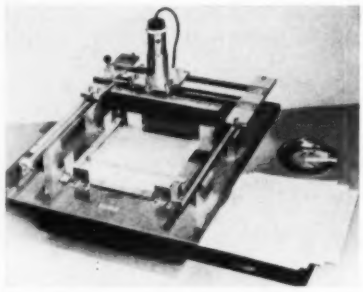
Circle 662 on Page 19

about 25 per cent in the next five years. For 1960, industry tire sales are expected to reach 127 million units, or 8 million more than in 1959. By 1966, a domestic demand for 150 million units is expected.

## Grant Sets Up Study Course In Systems Engineering

GRANT of over $20,000 has been announced by the National Science Foundation to support a summer conference for chemical engineering teachers. The conference, which will be held at Washington University from June 7 to 30, is designed to update a group of 30 qualified candidates in modern theory and techniques of systems engineering as applied to chemical processes. The event is co-sponsored by the American Institute of Chemical Engineers and the Foundation for Instrumentation Education and Research (FIER).

Closely identified with advanced industrial needs, the conference program will include lectures, laboratory experiments, and computer sessions. The computer portion of the course will occupy the final week of the conference and be carried out at the new Monsanto Chemical research center in St. Louis. There, the teachers will learn to program and use an IBM 704 computer. Actual industrial problems now under attack at Monsanto will be studied by the pro-



INFORMATION retrieval device developed by Jonker Business Machines Inc. identifies desired items by means of dots of light. In use, punched cards, each dedicated to a key word taken from a master list, are stacked in the machine. The serial number of each stock or file item conforming to a key word is identified by the co-ordinates of a hole punched in the card for that key word. Thus, light will shine through a stack of cards only at the co-ordinates of items possessing the characteristics of all the key words in the stack. Each card has a basic capacity of 10,000 items.

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Circle 663 on Page 19

# around the triangle

## LIQUID ADHESIVE DOES ASSEMBLY JOB

Substitution of a quick-setting adhesive for more conventional mounting methods is helping Electronic Associates Inc. to achieve greater miniaturization of electronic equipment. One application involves the mounting of electrical relays on potentiometers. The relay cases are made of irodite-finished aluminum, and the potentiometer covers of phenolic plastic. One drop of the adhesive makes an almost instant bond between the two dissimilar materials. Use of the adhesive (Eastman Chemical Products Inc. type 910) eliminates the need for relay mounting brackets and decreases the amount of wiring necessary. Quick-setting, high-strength bonds can be made with only contact pressure between virtually any combination of materials without the necessity of catalysts, heat, or solvent-evaporation delay times.

## A STEP TOWARD POWER SYSTEMS AUTOMATION

An electrohydraulic control system that is ten times faster and four times more sensitive than present mechanical controls for medium capacity steam turbine-generators has been announced by General Electric Co. A major breakthrough in the power generation field, the new system is viewed by the company's Medium Steam Turbine, Generator, and Gear Dept. as a big step toward power systems automation. The control system includes a tachometer generator, a pressure transducer, and a solid-state analog computer. The tachometer senses the turbine speed, the pressure transducer senses the extraction steam pressure, and the computer commands hydraulic positioning devices to control the turbine valves in accordance with both load and extraction flow demands.

## PROCESS MINIATURIZES STANDARD COMPONENT CIRCUITS

Electronic assembly technique which can cut equipment size by as much as 80 per cent has been developed by Sippican Corp. and Francis Associates. The process, designated MiniWeld, will be employed by Electronic Engineering Co. of Calif. in the design and development of electronic timing, instrumentation, data processing, and missile systems. It will also be used by a subsidiary, Engineered Electronics Co., in the mass production of solid state and vacuum tube packaged electronic circuits. In the process, standard electronic components are stacked into a module and then sandwiched between two or more Mylar sheets. The sheets contain a matrix of nickel ribbon wire leads which connect the components and interconnect the circuits. When the circuits have been formed by welding, the assembly is encased in an insulating compound.

## GAS PROCESS FINISH FORMS DIES AND MOLDS

New method of making forming dies, molds, and fixtures in pure nickel—without machining or hand work—has been developed by Carbonyl Metal Products Div., Budd Co. In the multistep process, a wood, plastic, or metal pattern is first sprayed with a eutectic compound. The sprayed form is then removed and placed in a depositing chamber. Using nickel carbonyl gas in an inert atmosphere, pure nickel deposits up to 0.400-inch thick may be produced on forms up to 60 by 100 inches in size. When the nickel-coated mold is separated from the sprayed form, the surface of the mold conforms exactly to that of the original pattern. Where necessary, the mold may be backed up with an epoxy resin form. Present uses include dies and expendable foundry items such as patterns, coreboxes, and diecasting and shell molds. Molds for complete aluminum engine-block castings are believed feasible.

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AUTOMATION

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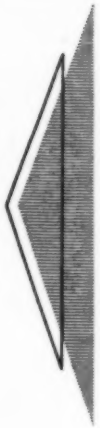

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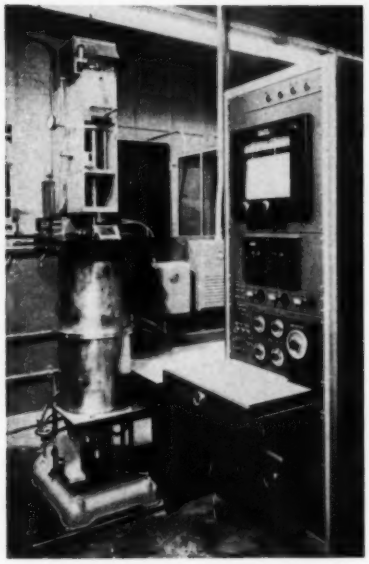

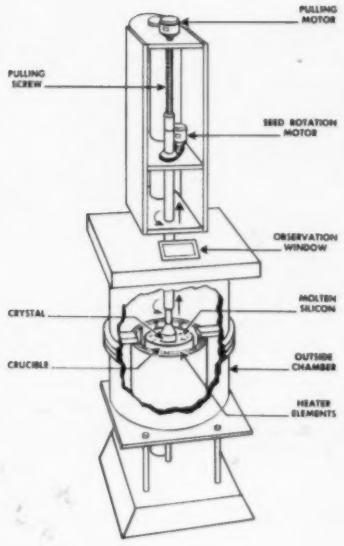


SEMIAUTOMATIC crystal growing furnace developed by Hoffman Electronics Corp. produces high quality monocrystalline silicon ingots for semiconductor products at three times the rate of former methods. Each operation including pre-gas, melt-down, pulling, and drawing an ingot is pushbutton controlled from a console. The speed of seed rotation, withdrawal time of the ingot, and cooling rate of the molten silicon can also be programmed on the console. Ingots weighing 530 grams can be produced in 150 minutes, with labor savings of 75 per cent over previous production practices.

fessors, and practical applications of systems engineering theory will be studied and worked on. Interested professors or instructors from AIChE-accredited schools should contact **Dr. Gerald L. Esterson,** Chemical Engineering Dept., Washington University, St. Louis 30, Mo., for application forms.

## Group Formed To Develop Electronic Product Ideas

ESTABLISHMENT of an Advanced Product Planning Operation to study opportunities for developing new and unique products for use in electronic equipment has been announced by the Electronic Components Div., General Electric Co. The new operation, to be headed by **Dr. Martin A. Edwards,** will consider electronics in its broadest sense—that is, having to do with the control of electron flow by whatever means possible, and not limited to vacuum tube, semiconductor, or other known techniques.

According to **L. Berkley Davis,** general manager of the Electronic Components Div., the development of totally new products with their resulting business opportunities are vital to the electronic components industry. However, it is difficult for operating departments to effectively evaluate and forecast the impact of new technologies in terms of either new business opportunities or the dangers of obsolescence in existing products.

The new organization will concentrate its efforts on the discovery of new products and applications that might otherwise be neglected in the normal, day-to-day activities of product departments. Thus, the operation will broaden the scope of planning and speed the implementation of discoveries in the field of electronic components.

## Production Techniques Key To Economical Tube Manufacture

PRODUCIBILITY was a prime requirement in the development of the nuvistor tube, and production techniques are undergoing continual improvement according to Radio Corp. of America. The nuvistor is a rugged vacuum tube that uses a ceramic and metal envelope instead of a conventional glass bulb. Advantages of the design include easy fabrication, small product size, and reliable operation at high temperatures.

Speaking at a recent divisional meeting of the American Institute of Electrical Engineers in Camden,


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If you have applications involving linkage or transfer of motion, SPHERCO Bearings can supply your needs in a wide variety of materials with a quality that will give you top performance under normal or high temperature conditions.

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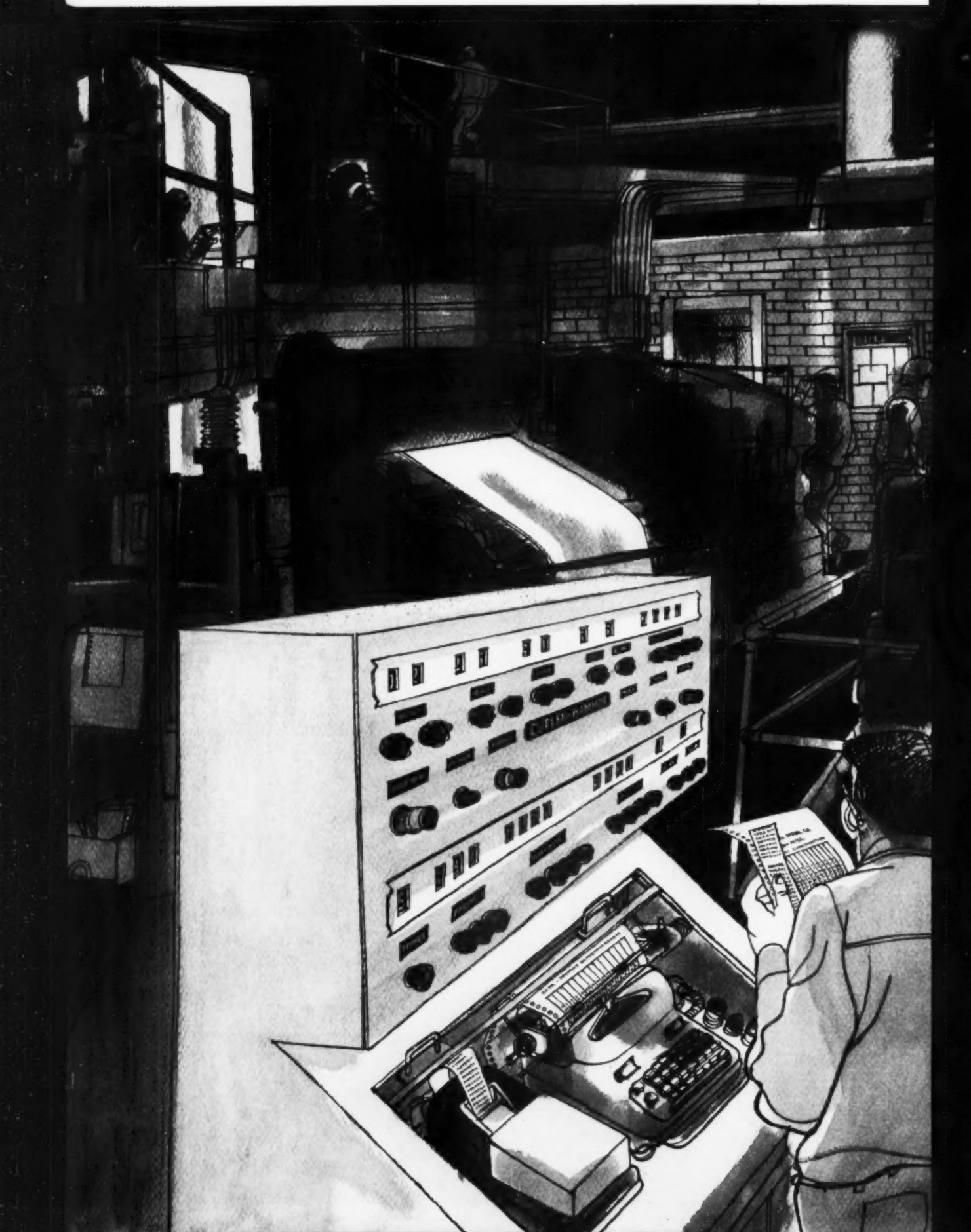

CONTROL

# *New machine with a memory licks a quality problem 3 miles long!*

ANOTHER NEW IDEA FROM CUTLER-HAMMER

When manufacturers started ordering up to 16,000 ft. of tinplate in one coil instead of sheets, it created a serious problem.

You can control sheet quality by running each one through sensing stations and separating them by predetermined standards. But how do you check and control quality in over three miles of tinplate that's all rolled up?

For an answer, a leading tinplate producer came to Cutler-Hammer. Working with him, Cutler-Hammer engineers devised a simple, yet ingenious solution. They developed a new type of computer that hooks onto the same sensing stations used for individual sheets.

As miles of tinplate whiz by these sensing stations *before* it's coiled, this computer remembers every defect. Then, it automatically records every defect's type and location on a tape. After checking the tape, exact quality is known. Production controls can be adjusted quickly to compensate for any deviations from standards.

**What's your problem?**

Cutler-Hammer is on the move. It's brimming with new products—a limit switch, for instance, that's twice as dependable as the ones you now use. It has the ideas and the engineering talent for designing systems that automatically handle everything from blast furnace charging to quality control. And the addition of Airborne Instruments Laboratory's microwave and electronic experience gives Cutler-Hammer unmatched capability in all fields of industrial automation.

The new trademark you see above symbolizes the vitality, the capacity for ideas and practical assistance you can expect from the *new* Cutler-Hammer. Phone your nearest Cutler-Hammer office to put it to work for you.

*WHAT'S NEW? ASK...*

**CUTLER-HAMMER**

CONTROL

Cutler-Hammer Inc., Milwaukee, Wis. • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.

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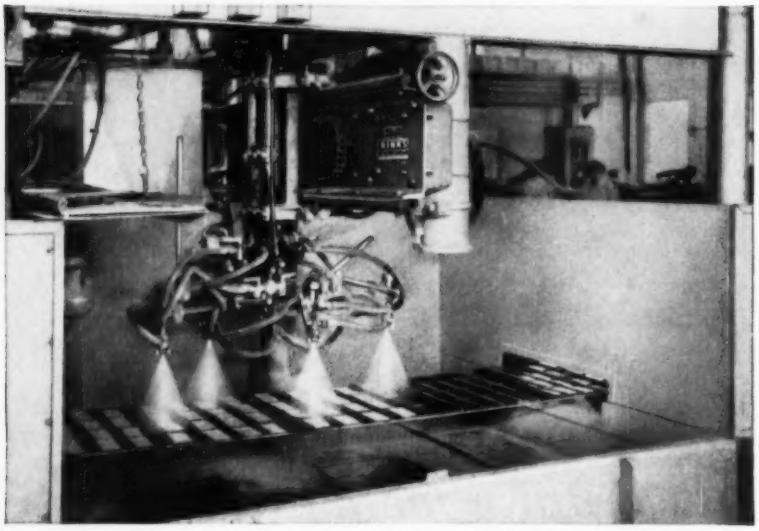

Tirelessly and with controllable uniformity, this Binks automatic spraying machine applies ground and cover enamels at speeds which match an automated production line.

**AT ERIE CERAMIC ARTS...**

# Automatic spray finishing boosts job enameling 20%

Mr. W. R. Lindner, president of The Erie Ceramic Arts Company of Erie, Pennsylvania, reports: "We use two Binks machines to automatically spray ground and cover enamels. The machines have been a perfect complement to the rest of our automated production. With only normal maintenance, the Binks units have worked beautifully since 1949. Equally as important as speed, we also improved our finishing quality."

**Finish 6000 pieces per hour**

Parts such as telephone number plates and meter dials are placed on pallets and pass through the spray booth on a conveyor. The automatic spray guns of the Binks horizontal reciprocating machine deposit a uniform 6 mil coating to the parts.

**Reduce material costs**

The spray guns are pneumatically operated and spray only when over the products being finished. Little material is wasted. Overspray is exhausted from the work area through a Binks spray booth. Slip is captured in a collecting pan and reclaimed for further use.

**Get the facts for yourself**

Binks engineers will be glad to show you how the proper spraying equipment, matched to your production rates, can give you higher quality finishes at lower cost. Call your nearest Binks Branch Office or write direct.

***Ask about our spray painting school***
***Open to all...NO TUITION...covers all phases***

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**Binks**
*EVERYTHING FOR*
*CERAMIC FINISHING*

SPRAY GUNS

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REPRESENTATIVES IN PRINCIPAL U.S. & CANADIAN CITIES • SEE YOUR CLASSIFIED DIRECTORY


N. J., **Richard N. Peterson,** engineer of the RCA Electron Tube Div., said, "New developments in continuous brazing furnaces and tube-evacuating equipment have advanced prospects for extremely economical production of the nuvistor." The tube went into commercial production last February.

In the continuous brazing operation, the tube parts are assembled in fixtures that support the electrodes in the proper positions. A single brazing operation then joins all of the parts of each tube. Success of the high-speed brazing method required prior development of a production technique for metalizing the ceramic tube bodies.

---

NEW firm, Keinath Instrument Co., has been recently formed to manufacture electronic and pneumatic recording instruments. Heading the new organization as president is **W. E. Van Horne**. Van Horne is a former executive of Industrial Nucleonics Corp. and has had prior experience in the instrumentation field with Brown Instrument Div., Minneapolis-Honeywell Regulator Co. The recording instruments produced by the company will be capable of plotting up to 400 variables on a single sheet of paper at rates up to 10 points per second. Although the greatest use of the devices will probably be in the process industries, Van Horne feels that analog recorders of this type will also see wide use for supervising material flows and inventories in manufacturing and warehousing operations.

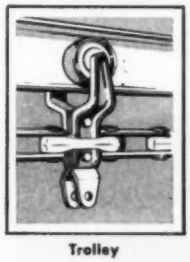
## Sixteen To One Output With Tape Versus Manual Control

PRODUCTION rates for contouring certain types of aircraft and missile parts were increased as much as 1500 per cent when magnetic tape controls built by Micro-Path Inc. were retrofitted to a Cincinnati No. 5 vertical milling machine to program an automatic machine cycle.

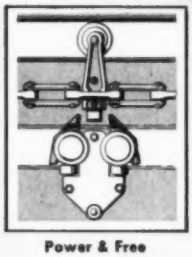
In one application, manual pro-

Circle 665 on Page 19

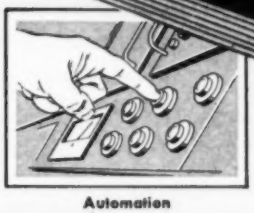
# EVER MEET THE FAMILY?



Trolley



Power & Free



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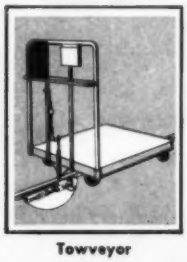

Towveyor

The Jervis B. Webb Company is in its 40th year of designing, manufacturing and installing custom engineered conveyor systems. We have also acquired a fine family of diversified industries that complement each other to provide complete customer service.

Each member of the family is a separate organization with highly skilled personnel who specialize in designing, manufacturing and installing: cranes and monorail systems; bulk handling systems; universal test equipment; and close tolerance forgings. End products differ, but the prime objective is the same—better production at lower cost.

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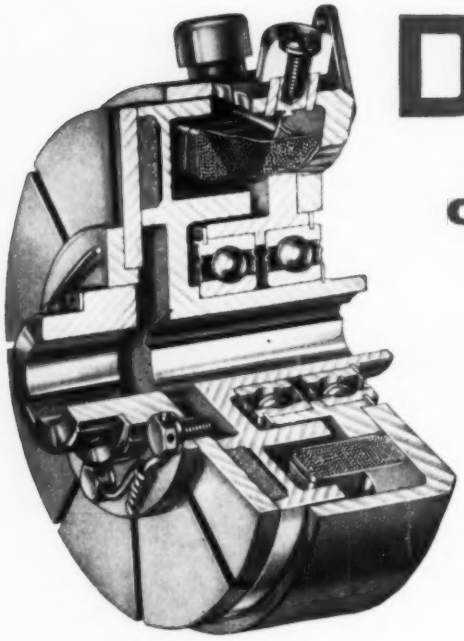
# Small Units for Big Jobs!

# EATON DYNA-TORQ

## MAGNETIC-FRICTION CLUTCHES and BRAKES



STATIONARY-FIELD, BEARING-MOUNTED DYNA-TORQ CLUTCH

### Now Available in a Full Line from 1¾" to 15" Diameter

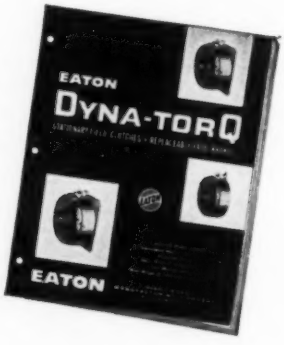
Eaton Dyna-torQ Magnetic-Friction Clutches and Brakes provide a simple, accurate, responsive method of controlling power and motion in today's complex production and processing machines.

The smaller sizes and advanced design types of Dyna-torQ Stationary-Field Clutches and Brakes enable Eaton to offer a well rounded line, including flange-mounted and bearing-mounted clutches, and replaceable-face brakes. Unique features of design and construction result in worthwhile maintenance cost savings. Dyna-torQ units, easily and quickly installed on new machines or existing plant equipment, deliver many highly desirable advantages.

### Dyna-torQ Magnetic-Friction Equipment Offers these Important Advantages:

- ★ Accurate power control
- ★ Dependable motion control
- ★ Rapid response
- ★ Easy "built-in" installation
- ★ Low maintenance costs
- ★ Compact plug-in type controls—may be remotely mounted
- ★ Inter-changeability of parts

Send for this illustrated bulletin giving complete description and specifications covering Dyna-torQ Stationary-Field Clutches and Replaceable-Face Brakes.



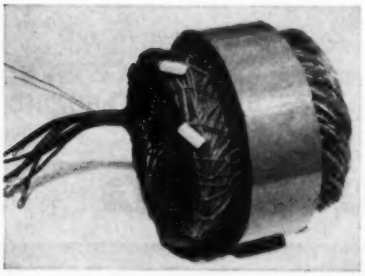

*Dyna-torQ Equipment is Available through Dynamatic Distributors in all Leading Cities*

**EATON**

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN



Circle 668 on Page 19



HEAT-SENSING switches that detect motor overloads can be buried in the stator windings of three-phase electric motors with ratings up to 125 horsepower. Developed by General Electric Co., the switches automatically stop a motor whenever its internal winding temperature exceeds a predetermined level. Speed of response is such that the switches afford protection against sudden overloads caused by single-phasing or stalling, or from rapid overheating due to accidental loss of ventilation.

duction of a 5/16-inch thick titanium part having 100 lineal inches of contouring required 4 hours. By using tape control of the work cycle and by stacking of blanks three-high on the worktable, the operation was completed in 45 minutes for an average of 15 minutes per part. The work cycle was completely automatic; manual labor was required only to load and unload the workpieces. Once programmed, the tape may be re-used to control production of the same part at a later date.

## Integrated Hot Strip Mill To Be Computer Controlled

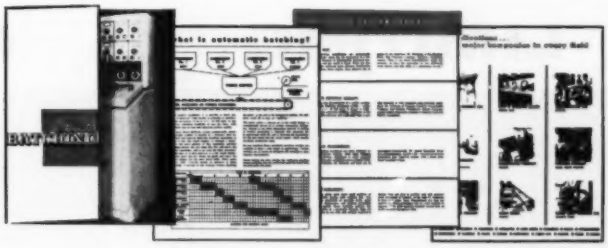
CONTINUOUS hot strip mill, under construction at Great Lakes Steel Corp., Div., National Steel Corp., will be controlled by an automatic digital computer system supplied by Daystrom Inc.

The system, employing a completely transistorized, general-purpose computer, will control all operations of the mill from the time slabs of steel enter the line until they emerge in the form of finished, hot rolled and coiled strip.

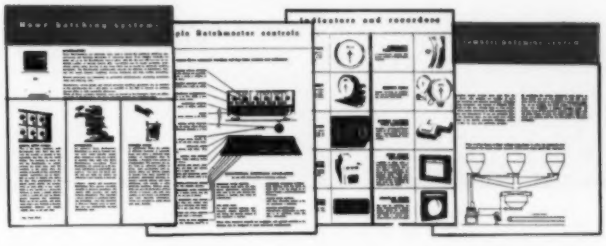
To accomplish this job, the control system will monitor 200 key points in the line and feed this information into the computer. At the same time, the computer will receive punched tape data relating to the number of slabs scheduled and the required characteristics and specifications of finished products.

Working continuously on this in-


# AUTOMATIC



# BATCHING



# HANDBOOK

*Everything you need to know about Automatic Batching*
*How to do it*
*How much it costs*
*What you need*
*How to use what you have*
*How to select the right system*

If you are now combining two or more ingredients in any kind of formula or batch, write now for this new automatic batching handbook. It describes in detail how automatic batching works, how to convert existing plant facilities or plan new plants for automatic operation. It illustrates the latest batching systems available, helps you select the right type for your particular needs. Also shows you how to combine materials handling equipment, storage facilities, and weighing equipment for greatest economy, increased production. This is the newest, most complete handbook on automatic batching available—be sure to write for your free copy today!

HOWE

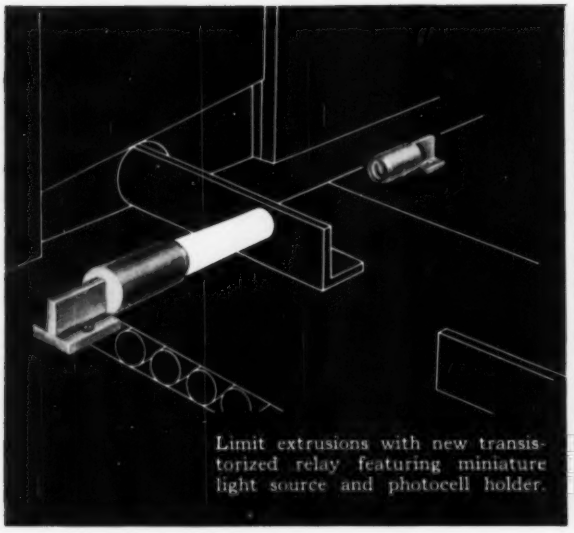
THE HOWE SCALE CO., RUTLAND, VT.
A SUBSIDIARY OF AMERICAN MANUFACTURING COMPANY, INC.
HOWE SCALES OF CANADA, MONTREAL, QUE.




Circle 669 on Page 19

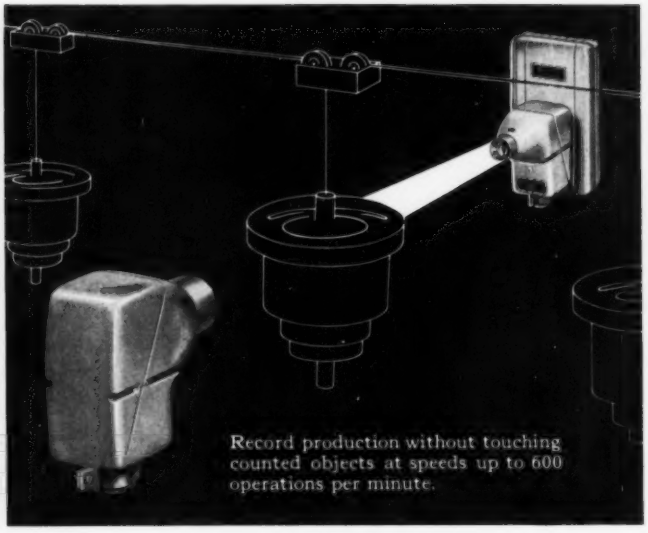
**FOR QUALITY . . . PRODUCTIVITY . . . PROFIT . . . MODERNIZE WITH GENERAL ELECTRIC**

## LIMITING



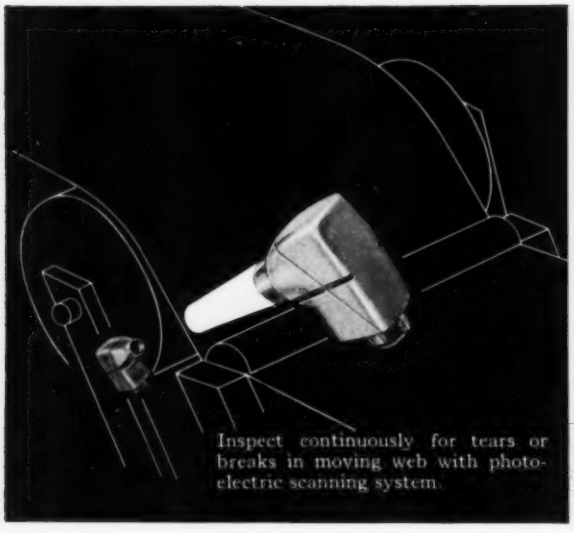
Limit extrusions with new transistorized relay featuring miniature light source and photocell holder.

## COUNTING



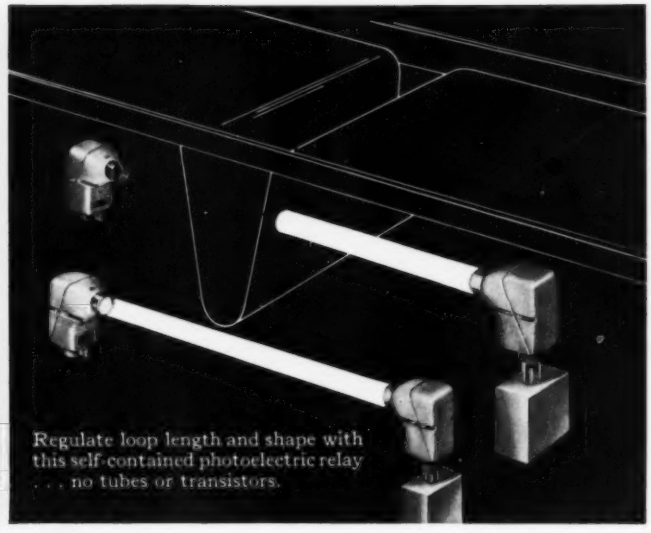
Record production without touching counted objects at speeds up to 600 operations per minute.

## DETECTING



Inspect continuously for tears or breaks in moving web with photoelectric scanning system.

## CONTROLLING



Regulate loop length and shape with this self-contained photoelectric relay . . . no tubes or transistors.

### A COMPLETE LINE OF GENERAL ELECTRIC CONTROL DEVICES

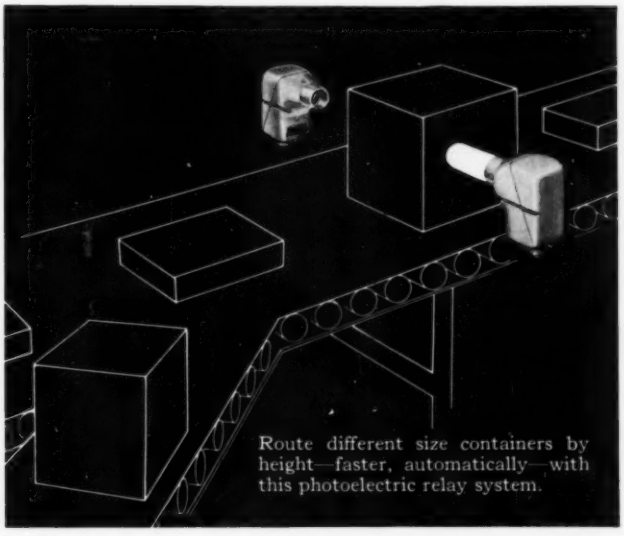
**Photoelectric controls**
- General-purpose
- High-speed
- Long-distance

**Electronic devices**
- Timers
- Resistance-sensitive relays
- Voltage-sensitive relays

**Photoelectric systems**
- Smoke-density indicators
- Side-register controls
- Cut-off register controls

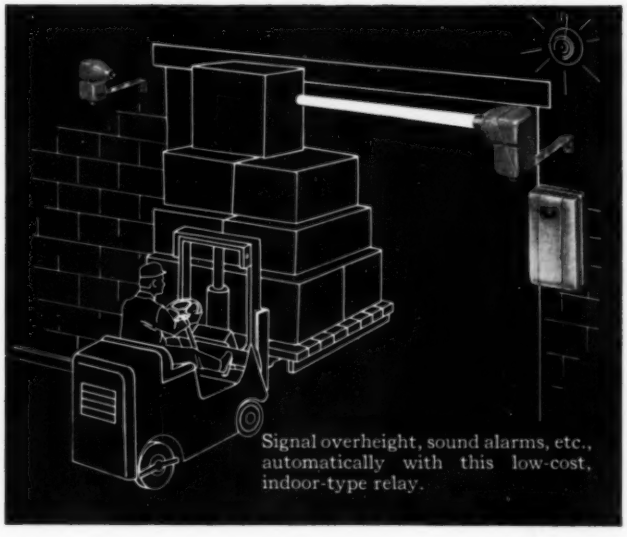
**PHOTOELECTRIC CONTROLS**

# SORTING



Route different size containers by height—faster, automatically—with this photoelectric relay system.

# SIGNALLING



Signal overheight, sound alarms, etc., automatically with this low-cost, indoor-type relay.

**CONTROLS FOR AUTOMATION**

**Switching . . . inspecting . . . counting . . . diverting . . . sorting . . . controlling.** These are but a few of the *hundreds* of applications where General Electric photoelectric controls are helping our customers move closer to the benefits of automation—increased productivity, lower costs, higher quality.

Users are finding *new* ways to fit General Electric photoelectric devices into their production processes every day . . . for good reasons: These versatile G-E controls are designed for heavy-duty industrial use. They're easy to install, and require virtually no maintenance. They are highly dependable throughout a long operating life. In fact, General Electric photoelectric controls feature lamps with life expectancy of 10,000 hours—more than a year of round-the-clock operation!

**ONE-YEAR WARRANTY, IMMEDIATE STOCK SHIPMENT**

General Electric photoelectric and electronic devices carry a standard one-year warranty for your protection. And, your order for standard catalog devices is filled immediately from one of six regional warehouses. Also, replacement parts are warehouse-stocked, too, for your convenience and protection.

For expert help in applying General Electric photoelectric devices to your operations, call your nearby G-E Apparatus Sales Engineer or Distributor today. And, for your personal copy of our Photoelectric Devices catalog, mail the coupon below. *General Electric Co., Specialty Control Dept., Waynesboro, Va.*

**SEND TODAY FOR FREE CATALOG**

**General Electric Co., Section B793-02**
**Schenectady 5, New York**

Please send me a copy of the G-E Photoelectric Control catalog, GEA-6822, with description, specifications, and pricing data on the complete line.

**Name** _____

**Company** _____

**Address** _____

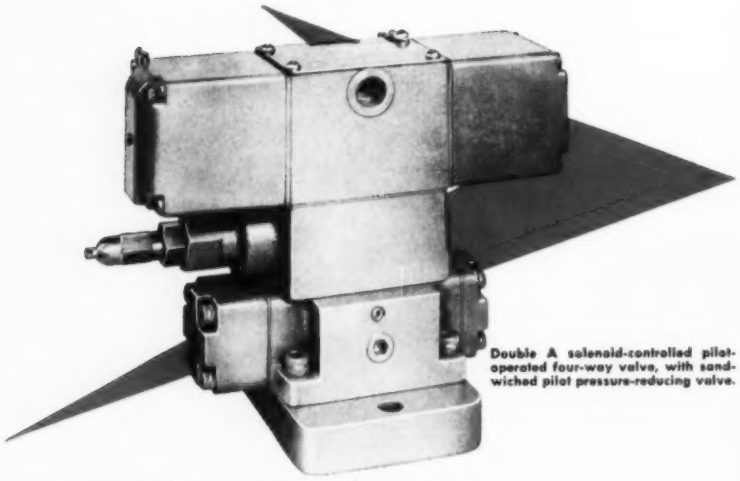
**City** _____ **State** _____

*Progress Is Our Most Important Product*

**GENERAL ELECTRIC**



Circle 670 on Page 19



Double A solenoid-controlled pilot-operated four-way valve, with sandwiched pilot pressure-reducing valve.

*From Brown & Sharpe–*

# These Big Double A Valve Features

Get *all* the features *you want* in the valves you buy. Get JIC standards *plus* these extra features and choices by buying Double A solenoid-controlled, pilot-operated directional valves:

- **Choose from four different solenoids: AC, DC, AC oil-immersed, and DC with palm-button.**
- **Solenoids have rubber shock absorbers and exclusive separate drain for more reliable, faster action.**
- **Just one solenoid and pilot valve combination will serve four valve bodies with pipe connections from ⅜" through 2", and three pressure capacities (2,000, 3,000, and 5,000 psi).**
- **New optional CircuitStak pilot pressure-reducing valve sandwiches between main body and pilot valve to make possible higher pressure operation of the main valve body.**
- **New optional CircuitStak pilot flow-amplifying valve requires no piping, provides faster spool shifting of larger valve sizes.**
- **Fifteen different standard cataloged main valve spool types are available, to accurately match your demands.**
- **Two kinds of sub-plates, the usual back-entering plus the back-and-side entering type, are offered.**
- **SAE straight thread openings are optional at no extra cost.**

See for yourself how much more Double A valves offer, from the sensible flow ratings (based on *minimum* pressure drops) right down to the extra mounting bolts (to prevent O-ring troubles under high pressures). Contact your nearest Double A hydraulic distributor. Or write to **Double A Products Co.,** a subsidiary of Brown & Sharpe Mfg. Co., Manchester, Michigan.

**Brown & Sharpe**
**HYDRAULICS DIVISION**

**GEAR, VANE & CENTRIFUGAL PUMPS**
**DOUBLE A VALVES**
**GEROTOR PUMPS**
**POWER UNITS**

**PROGRESS IN PRECISION FOR OVER 125 YEARS**

**COMPLETE INFORMATION**
**on Double A solenoid-controlled sub-plate mounted four-way valves.**
**ASK FOR**
**Series 9000 Engineering Data Sheets.**


formation, the computer will follow each slab as it moves through the process (at speeds up to 2700 fpm) and automatically control temperatures, roll screwdown settings, and strip width to suit the predetermined product requirements. The system will also print out detailed information on each slab and give an alarm if any operation fails to meet preset standards.

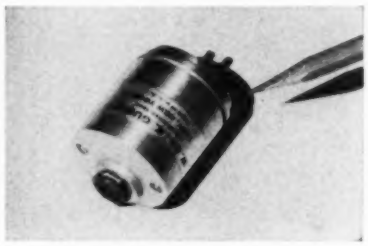
The seven-stand, 80-inch mill will be equipped with an $8 million electrical system to be supplied by General Electric Co. Included in the system will be two 7000 horsepower and five 8000 horsepower double-armature motors that will supply a total of 54,000 horsepower. Other components of the electrical system will include individual rectifiers and speed regulators for each motor.

Shipment of the electrical equipment is scheduled for the second quarter of 1960, with startup of the mill scheduled for late in the third quarter.

## Programmed Checkout Systems Make Line And Shop Tests

PRODUCTION models of a tape-reading, semiautomatic checkout system for the electronic equipment in the Navy's A3J Vigilante attack bomber have been delivered by Autonetics, Div., North American Aviation Inc.

Specific equipment items to be checked out by the system and its adapter units include flight control,



PHOTOELECTRIC pulse generator developed by Industrial Div., W. & L. E. Gurley, may be used as a rate generator or an angle-measuring unit. Pulses are generated as a light beam passes through clear sectors in a shaft-driven disc and impinges upon a photocell. When the device is used to measure angles, individual pulses are counted; when used as a rate generator, the output frequency is read in terms of shaft speed. Standard discs are available that provide up to 500 pulses per revolution.


Circle 671 on Page 19

# Fairbanks Nº 1

*a scale, our first one.*
*an imagination of iron, brass, copper and lead,*
*fashioned in a New England workshop.*
*inanimate.*

*but it spoke—*
*a different kind of language,*
*of pounds and ounces and fractions thereof*
*and it spoke only the truth.*

*it felt—*
*the roundness of grain, the smoothness of marble,*
*the sweetness of candy and the authority of gold.*

*it heard—*
*the sound of life, babies newborn*
*it cradled them and recorded their growth*
*until pounds and ounces were replaced*
*by years and months.*

*it traveled—*
*by packet boat down the Mississippi,*
*by clipper ship to England,*
*The Sandwich Isles, the Indies,*
*South America and China.*
*better known throughout the world*
*than anything else made in America.*

*it was relied on*
*by farmers, merchants,*
*scientists and doctors.*
*it witnessed history;*
*influenced it and was part of it.*

*its descendants have new names.*
*floaxial dial, mercoid switch,*
*reed switch and cotton lap;*
*remote control,*
*printomatic,*
*electronic and levetronic.*
*all serve to evaluate and control*
*the substances that make up*
*the universe.*

*raw materials*
*or manufactured articles;*
*things unseen or man himself;*
*all have weight and must be measured . . .*
*our scales do the job.*

*and the new challenge—*
*weight in motion . . .*
*freight trains in transit,*
*trucks too busy to stop,*
*liquids coursing through miles of pipe . . .*
*our scales will do the job.*

*but this was our first—*
*Fairbanks No. 1*
*and we hold it in special reverence*
*for it weighed the most precious thing of all.*
*it weighed an idea.*

Scales for heavy industry and for business; scales for science and for the home. Scales that weigh milligrams or millions of pounds. Scales that weigh missile fuel loads at Cape Canaveral; trucks on the Golden Gate Bridge; onions at your neighborhood grocer's . . . we make every kind of scale for every kind of purpose, including electronic scales. We are the Number 1 manufacturer of scales and automated weighing systems in the world.

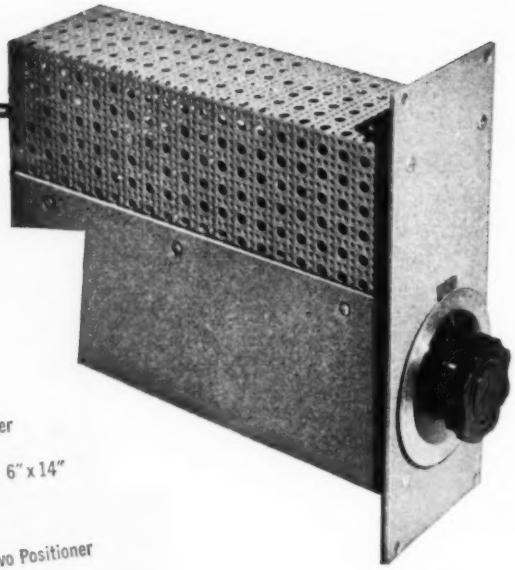
If you have a problem where the careful calculation of weight is of vital importance, please write to Mr. Robert W. Kerr, President, Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Illinois.

# Fairbanks, Morse

A MAJOR INDUSTRIAL COMPONENT OF FAIRBANKS WHITNEY CORPORATION, NEW YORK

Circle 672 on Page 19

# immediate answer to a remote problem



Electric Motor Speed Control

Numerical Machine Control

Engine Throttle Control

**Design Project:** ET 580 **Component:** Remote Servo Positioner
Industrial TV Camera

**Design Project:** TV 12 **Component:** Remote Servo Positioner
**Function:** Traverse Azimuth & Elevation
**Specifications:** 1. Compactness: Servo 18 lbs. or less; 6" x 14"

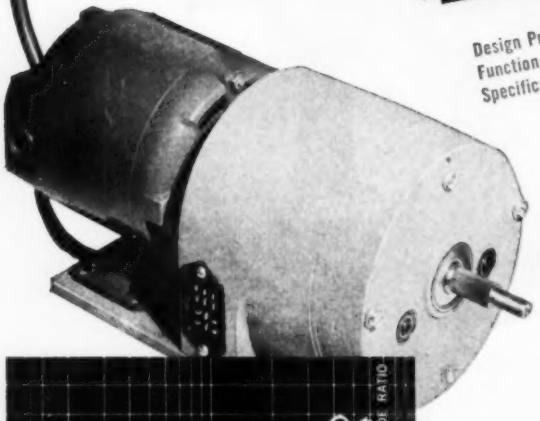
Table Positioning Machine Tool Control

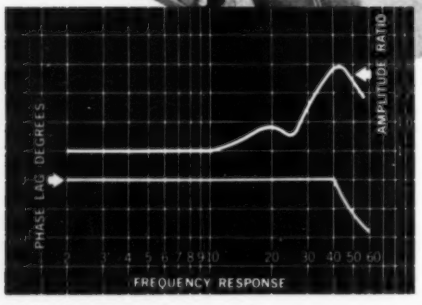
**Design Project:** AM 412 **Component:** Remote Servo Positioner
**Function:** X-Y Table movement.
**Specifications:** 1. Accuracy: Position lead screw within ¼-degree. (table accuracy .0025 inch)
2. Direction: Forward & reverse.
3. Frequ[illegible]
4. [illegible]

Remote Positioning—Nuclear Reactor Rods

**Design Project:** NR 3406 **Component:** Remote Servo Positioner
**Function:** Rod position control.
**Specifications:** 1. Response: Maximum speed within 1/50 second.
2. Accuracy: Within .01-inch over 108" travel.
3. Reliability: Ultimate.
4. Torque: 250 inch pounds @ 12 rpm.
5. Fail Safe: Free fall with automatic braking.

**Recommendation:** Leartron 60 **Approved** HF
**Requisition:** NR 48261






*Total shaft movement equals one-quarter degree.*

**Watch the LEARTRON demonstrate 3-axis control by actually threading a needle at the Design Show—Booth 339.**

# LEARTRON 60

## FOR PRECISION REMOTE CONTROL

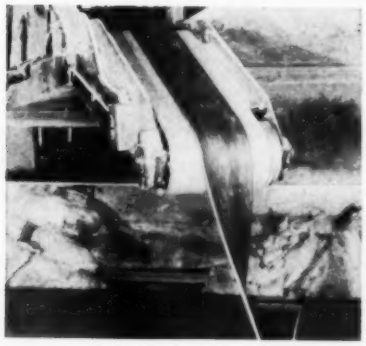
Designers are fast finding that the "Leartron 60" remote positioning system measures up to . . . and beyond . . . some of the most stringent specifications. It's not surprising; all Lear industrial products and systems reflect the demonstrated reliability and quality which have made Lear the leader in the aircraft and missile field for over 30 years.

Perhaps you have a problem requiring a look outside the field of conventional products—electro-mechanical, electronic, or hydraulic in nature. If so, may we help?

INDUSTRIAL PRODUCTS
**ELECTRO-MECHANICAL DIVISION**
110 Ionia, N.W., Grand Rapids, Michigan

**LEAR**

EM 11



RESIN-BONDED coating of tetrafluoroethylene applied to woven cotton belt prevents sticking of hot rubber strip as it is removed from a masticating mill. The belt is used between the mill and an extruding press at Dunlop Tire & Rubber Corp. Supplied by Globe Woven Belting Co. Inc., the belt was coated by spraying with a plastic dispersion prepared by Acheson Colloids Co.

navigation-bombing, master flight reference, radar altimeter, air data computer, electronic countermeasures equipment, communication, navigation, identification, and primary power.

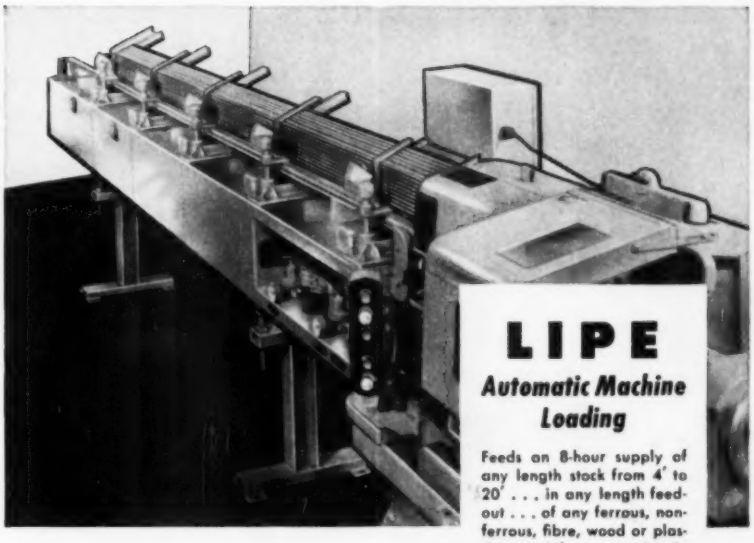
The checkout system comes in two packaging configurations: Mobile carts are available for flight line or carrier-deck checkout and troubleshooting, and standard shop or hanger-deck benches are used for isolation and repair of specific malfunctions.

Major components include a tape programmer, comparator, analog-to-digital converter, counter and timer, decoder, printer, control panel, operating time indicator, and air conditioner. Adapter units match specific systems under test to the simulation and measuring equipment.

At line level the checkout system has programmed, self-checking features complete enough to provide a "confidence level" check. At shop level the system determines the specific, faulty module that gives a "no-go" indication in a line check.

## Microwave Hookup Links Operating Gas Companies

MICROWAVE communication system being installed by Columbia Gas System Inc. will link subsidiary companies on a 470 mile route extending through four states. The systems will provide operating companies with voice communication, teletypewriter service, facsimile fa-



LIPE
Automatic Machine Loading
Feeds an 8-hour supply of any length stock from 4' to 20' . . . in any length feed-out . . . of any ferrous, non-ferrous, fibre, wood or plastic material . . . ranging in diameter from 1/16" to 1 1/2".

# Continuous Automatic Feed

***of bars, rods, tubing in practically every shape used!***

LIPE AML Bar Feeds will give you faster, finer production with less scrap and refinishing and a more efficient use of manpower.

They are applicable to a wide variety of machines, including single-spindle automatic screw machines, turret lathes, centerless grinders, abrasive-wheel cut-offs, punch presses, cold headers, die machines and others.

Sold and serviced by franchised distributors in principal industrial areas. Write or wire for complete information.

**STOP CUTTING AIR AND YOU START CUTTING COSTS**

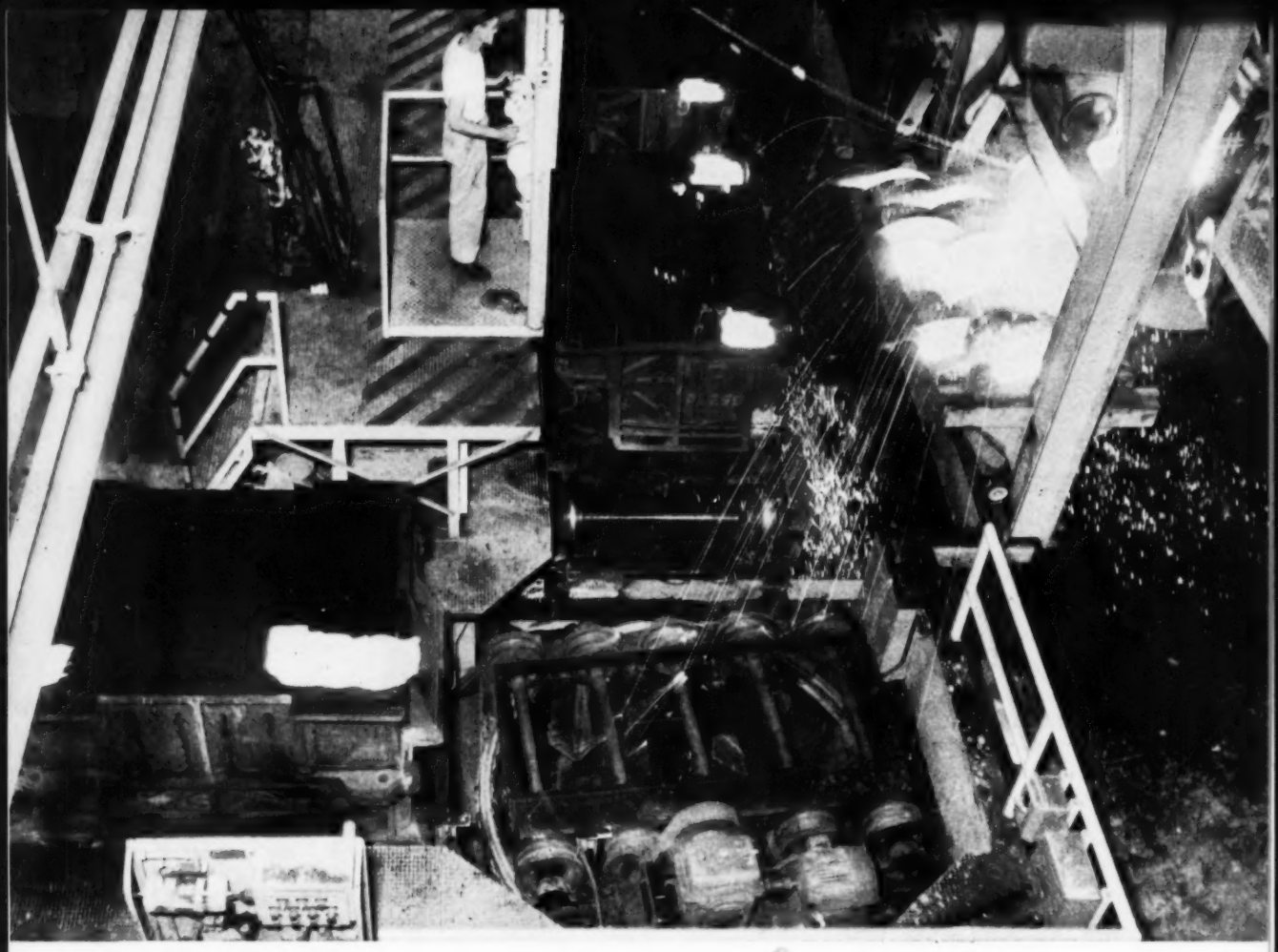
LIPE ROLLWAY

Lipe-ROLLWAY CORPORATION
SYRACUSE 1, N. Y.

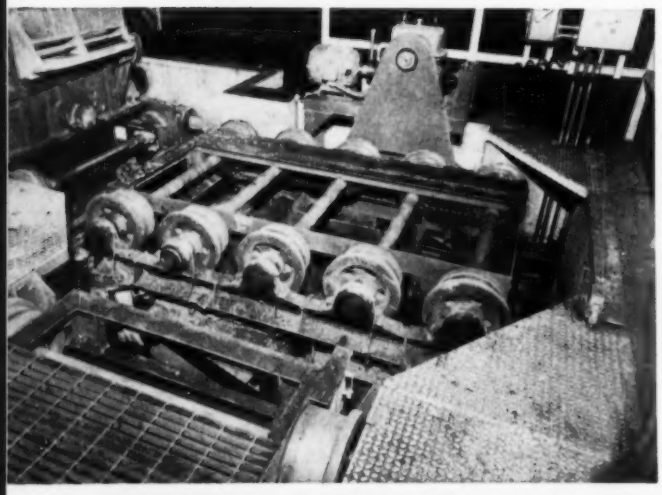
PIONEERS IN PNEUMATIC BAR-FEEDING



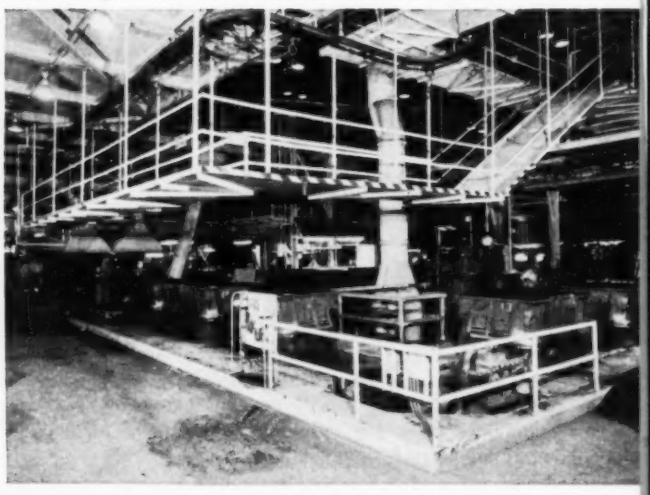

Circle 674 on Page 19



# Logan *Plant Dynamation* paces



Close-up view shows one of the specially designed wheel conveyors mounted on automatic air-driven turntable. System traveled by molds is made up of individually-powered conveyors about this length.



Second turntable occurs midway in cooling zone, dispatches molds toward automatic shake-out. Each conveyor indexes one mold in cascading order, eliminating gaps and synchronizing flow.

### *Logan conveyors move a nine-ton mold every minute at American Radiator & Standard Sanitary Corp.*

Modern casting equipment offered a high potential rate of output for this new major foundry in Louisville, Ky., but actual capacity would hinge to an important degree on conveyor design.

Large bathtub castings would need to be conveyed safely and rapidly through a U-shaped conveyor system while the metal was in the molten state. Each tub mold (metal, containing flask, and delicate sand mold) would weigh 18,000 lbs. To prevent crumbling, the conveyor ride would have to be exceedingly smooth. All steps on the casting floor had to be synchronized for fast continuous operation.

The Logan conveyor engineer collaborated with foundry equipment specialists to create a largely automatic casting floor system. The production pace achieved was one bathtub casting every minute!

Specially designed heavy-duty live flanged wheel conveyors give the necessary speed and smoothness. Molds glide through the two required turns on automatic air-powered turntables. Gaps between molds in the 256-ft. wheel system are eliminated by automatic indexing. The turntable shown at left has dispatched a mold to the cooling zone—now returns to pick up next mold from the pouring line. Ladles pour during turntable's indexed one-minute cycle.

The U-shaped automatic wheel series runs from the make-up zone to "shake-out," where hardened castings are removed. Two chain conveyors take automatically-removed flask parts quickly back to make-up for re-use.

(Right) After "shake-out," Logan overhead trolley conveyors carry castings through a bridge into blast-cleaning areas in next building.

# new foundry to capacity

### *Logan conveyor design helps harness ALL the work-power potential of your plant*

The productive power of today's machinery is tremendous, but a hundred fine machines still may not make a plant. Harnessing and activating all this potential work-power requires both skill and an adequate design concept. It can be a main key to success. Full *dynamation* of the plant comes only through the one right custom-designed conveyor system.

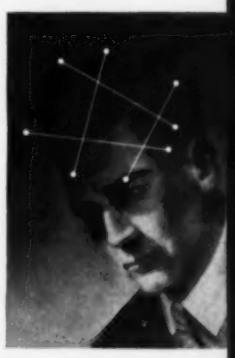
*The Logan technique of Plant Dynamation* ensures this one right system. The Logan engineer works with you through an exact analysis; then section by section he designs and specifies the conveyor dictated by the special dynamics of your plant.

*Over the half-century* in which production-line industry itself has grown up, Logan engineers have developed and extended the Plant Dynamation concept. On an average, "The Man From Logan" assigned to your area has participated in 14 years of this vital experience.

*Only a complete-line conveyor company* like Logan has the range of products to back up Plant Dynamation. To give your plant its one right system, the Logan engineer specifies freely from equipment in the five distinct modes of conveyor power and control: gravity, electricity, hydraulics, pneumatic devices and electronics.

*Logan Dynamation Centers* —complete master control centers—are well known in industry. The unusual ability to design complete controls as well as extensive automatic conveyor systems makes the Logan engineer especially valuable where the job requires close collaboration with other engineers.

*"The Man From Logan"* stationed near you is quickly available. This qualified specialist works with your engineers through design and installation to smooth operation. It is important to consult him early. Write or phone today for a conference on the *dynamation* of your plant.



**Logan Conveyors**

LOGAN CO., 218 CABEL ST., LOUISVILLE 6, KY.

Circle 675 on Page 19

**COST-CUTTING PRODUCTION TEAM!**

*. . . the two-way answer to assembly problems*

Here's a combination that cuts production costs and gets rid of assembly problems in a hurry—Milford Tubular Rivets made to high quality standards to assure a better finished product for you... Milford automatic rivet-setting machines that can be quickly adapted to your particular fastening needs.

Milford's MANUAL OF MODERN RIVETING PRACTICE may have the answers to your riveting problems. Ask a Milford Representative to show you how to use this manual to cut production costs.

THE MILFORD RIVET

**MILFORD RIVET & MACHINE CO.**

MILFORD, CONNECTICUT • NORWALK, CALIFORNIA
ELYRIA, OHIO • AURORA, ILLINOIS • HATBORO, PA

cilities for telemetering, supervisory control, and data communication. Up to 240 communication channels will be available.

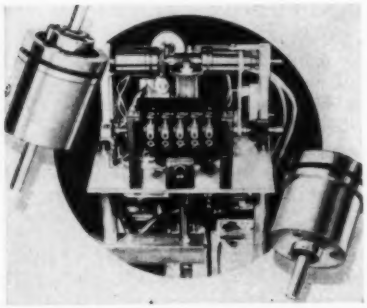
Costing $1.5 million, the completed system will include 29 stations, each equipped with Collins Radio Co. communications equipment. Operation will be in the 6000 mc band subject to approval by the Federal Communications Commission.

Power source for each station will be a bank of 24-volt batteries, with standby generators to satisfy the ac requirements for chargers, tower and building lights, and antenna heaters.

To improve reliability, the radio frequency equipment will employ hot standby operation; that is, both the main and standby equipment will be fully powered, with the standby unit ready to assume the communication load rapidly in case of failure of the main equipment. The carrier equipment provides for standby operation for all units that affect 13 or more voice channels. Alarms are provided to give instant warning in case of failure of the radio frequency or carrier equipment.

## SPOTLIGHTING PEOPLE

**Robert E. Wilson** appointed manager of a new industrial electronics plant which will be built in Washington County, Pa., by Radio Corp.



MINIATURE clutch and brake assemblies supplied by Simplatrol Products Inc. are used in an auton.atic micrometer developed by J. W. Dice Co. The clutch is a part of the drive for a part-sensing screw. When the screw contacts a part being measured, the clutch disengages, stopping further advance of the screw. At the same time, the brake stops the spindle of a digital readout counter to provide a reading. Accuracy of the instrument is within 0.000010 inch.



Circle 676 on Page 19

Circle 677 on Page 19→

GENERAL ELECTRIC
*Offers a Complete Line of*

# ADJUSTABLE-SPEED DRIVES

*MECHANICAL*
*ELECTRIC*
*ELECTRONIC*

TO MEET EVERY APPLICATION REQUIREMENT

*Horsepower*
1/4 to 1250

**TIMED OR CURRENT LIMIT**
***Acceleration or Deceleration***

*OPERATES FROM AC POWER SOURCE*

**R. P. M.**
***2 to 6000***

**SPEED RANGE**
***Up to 200:1***

***SPEED REGULATION***
10% to 0.1%

**Constant HP**
**Constant Torque**
**Or Both**

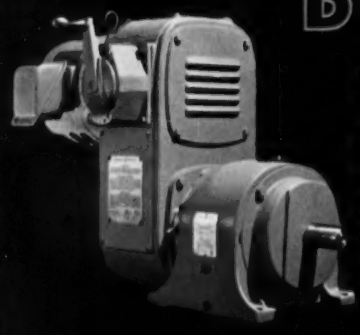
***Remote Preset Speed Control***

**SELECT YOUR DRIVES** *from*
*General Electric's Complete Line*
*Shown on the Following Pages*

GENERAL ELECTRIC

# GENERAL ELECTRIC *Adjustable-Speed Drives Offer* *A Great Opportunity*

## POLYDYNE® DRIVE



Modern, a-c mechanical drive. ¼–25-hp. Speed range to 10:1. New "Equalizer"‡ provides smooth manual or automatic speed control. Produced by Gear Motor & Transmission Components Dept., Paterson, N. J. Write for Bulletin GEA-6806*.

‡ Pat. Pending.

## THYMOTROL† *SPEED VARIATOR*

High quality electronic drive. ¼–10-hp. Wide speed range. Small, lightweight. General Purpose and High Performance types. Write for Bulletin GEA-7018 and GEA-7019*.

## *KINAMATIC*® *Speed Variator*

Industry's most versatile electric drive. 1–500-hp. Features Kinamatic motor-generator conversion. Speed range up to 200:1. Precise regulation. Regeneration. Wide variety of power unit, motor and control modifications available. Write for Bulletin GEA-6643*.

*Industry's most complete line of modern packaged drives for every performance level, every price range*

General Electric adjustable-speed drives are available for every performance level, every price range to help you boost output, improve quality, increase machine flexibility, reduce installation costs, cut your maintenance budget, add substantial profits to your business.

To make possible these advantages, your General Electric sales engineer is backed by an experienced team of adjustable-speed drive specialists—men who work constantly to help you get more out of your machines.

They offer an unbiased, analytical evaluation of your requirements—recommend the adjustable-speed drive that meets the demands of your application most completely and economically.

GENERAL ELECTRIC

# *to Modernize for Increased Profits*

## KINATROL✢
### SPEED VARIATOR

Outstanding packaged drive value. Compact, versatile eddy current coupling. 3–100-hp. Stepless speeds 1½:1 to 17:1. 2% speed regulation. For complete information write for Bulletin GEA-6885*.

## Parmatic
### *SPEED VARIATOR*

Power amplistat conversion features hermetically sealed silicon rectifiers. 1–200-hp. Speed ranges to 200:1. Lightweight, quiet and vibrationless. Field proven. Write for Bulletin GEA-7012*.

** Write to Section 821-4, General Electric Company, Schenectady 5, New York.*

*In Canada, write Canadian General Electric, Peterborough, Ontario.*

✢ Trademark of General Electric Company.

### *RESEARCH*

**In product research, G.E. invests more than three times the industry average. You benefit from the most modern features in your G-E drive.**

### *ENGINEERING*

**General Electric industry and application specialists, familiar with your production process, assure proper selection and design of G-E adjustable-speed drives to meet your specific application requirements.**

### *MANUFACTURING*

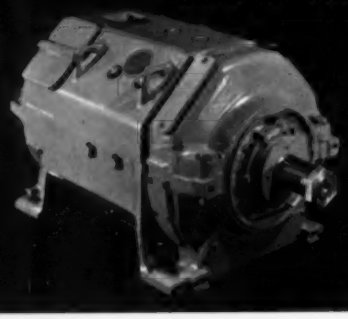
**Skilled G-E workers, modern production facilities, standardized components and latest testing methods combine to give you high-quality, adjustable-speed drive equipment, shorter delivery time, lower prices.**

### *SERVICE*

**G.E.'s service network offers three-way 'round-the-clock' assistance: start-up service, productive maintenance assistance and complete repair service.**

## MD ARMORED MOTORS

Industry's most preferred d-c mill motor. 500 to 625-hp. Write for Bulletin GEA-4654C*.

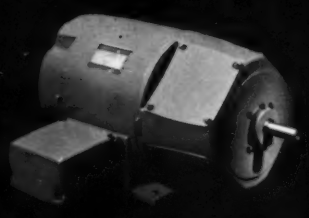


## KINAMATIC® D-C MOTORS

Most modern, versatile d-c motor for adjustable speed. 1 to 200-hp. Write for Bulletin GEA-6335*.

## AMPLIDYNE POWER AMPLIFIERS

Fast response d-c power source with flexible output characteristics. Write for Bulletin GEA-4053B*.



## *PLUS . . . industry's most complete line of drive components for both general purpose and special industry application*

To learn more about the modern capabilities of G-E packaged drives and components, call your nearby General Electric sales engineer. ADJUSTABLE SPEED, a new booklet which outlines G.E.'s complete line of modern packaged adjustable-speed drives, is also available to help you modernize for profits. Ask for Bulletin GEA-6999*.

**** Write to Section 821-4, General Electric Co., Schenectady 5, N. Y. In Canada, write Canadian General Electric, Peterborough, Ontario.***

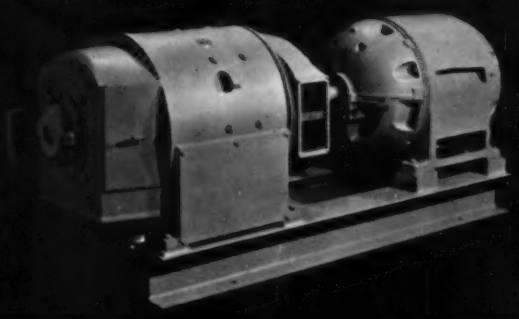
DIRECT CURRENT MOTOR & GENERATOR DEPARTMENT

**GENERAL ELECTRIC**

ERIE, PENNSYLVANIA

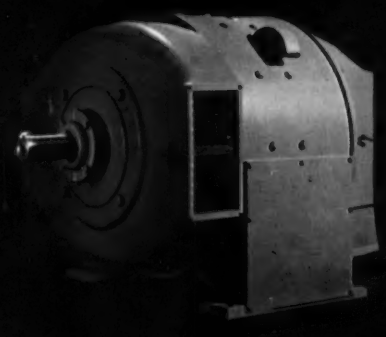
## HEAVY DUTY M-G SETS

Reliable power conversion for main, auxiliary and process line drives



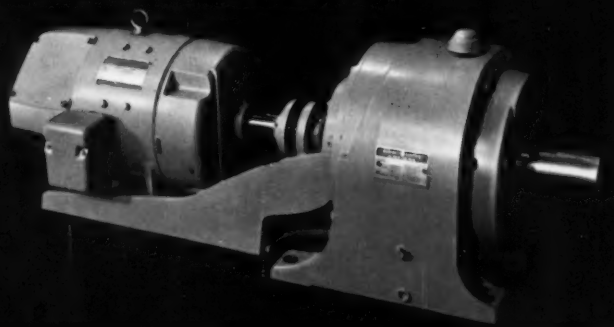
## CD-1000 D-C MOTORS

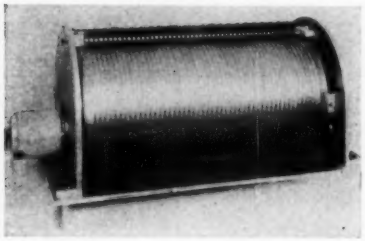
Performance proved. Quality designed. 250 to 1250-hp. Write for Bulletin GEA-5497A*.



## ALL-MOTOR GEAR-MOTOR

A-c or d-c. 1 to 75-hp. Simplified maintenance. Produced by Gear Motor & Transmission Components Dept. Write for Bulletin GEA-6704*.





DIGITAL magnetic memory drum developed by Consolidated Controls Corp. provides sufficient power output to actuate logic circuits directly, regardless of drum speed. Multiple read heads, in the form of bistable magnetic amplifiers, provide either a "one" or a "zero" output signal depending upon the polarity of magnetization of the drum segment encountered. Unit can be used to provide variable delay for automatic inspection devices and sorting conveyors; program control for automatic machine tools; and conversion of binary codes from parallel to serial and reverse.

of America. . . . **William Lawrence** named director of operations for the Electronics Div., and **William F. Conway** appointed manager of production engineering in the Commercial Products Div., Stromberg-Carlson, Div., General Dynamics Corp. . . . **Horace W. Thue** named assistant general manager in charge of manufacturing, General Products Div.; **Francis G. Paul** appointed general manager of the Endicott plant, General Products Div.; and **Warren K. Lind** named assistant general manager of the Poughkeepsie plant, Data Systems Div.—both divisions of International Business Machines Corp. . . . **Gregory C. Gates** appointed purchasing manager of Pratt & Whitney Co. Inc. . . . **W. C. Purple Jr.** named vice president—production at Melpar Inc., subsidiary of Westinghouse Air Brake Co. . . . **Robert L. Deneau** appointed assistant to the general sales manager of Buhr Machine Tool Co. . . . **Norman Fischell** named vice president in charge of production at Circo Equipment Co. . . . **Robert E. Boyden** joined Dashew Business Machines Inc. in a newly created post of vice president of production and engineering. . . . **Emil C. Steinle** appointed superintendent in charge of optics manufacturing and precision instruments manufacturing, Apparatus and Optical Div., Eastman Kodak Co. . . . **George S. Stuart** named production manager, Magnetron Product Line; **John V. Lyddane** appointed production man-

# Save up to ⅓ on the cost of your next conveyor...new handbook shows how

**Tells how to cut planning and installation costs with pre-engineered, ready-built conveyor components for immediate or future handling needs**

Install a conveyor system to meet your specific materials handling needs today . . . tomorrow . . . or in years to come. Using Standard's Handidrive handbook, simply order pre-engineered, prebuilt interchangeable conveyor components to which additions or alterations can be made as required.

"Do-it-yourself" buyer-users will find Handidrive assembly is fast, easy. The pre-engineered stock units include: roller conveyors (either gravity push-along or live roller type), inclined belt conveyors, drive units, intermediate sections, curved sections, supports, hangers and other miscellaneous items.

Lower initial cost — you buy only what you need — is only one of many Handidrive "off-the-shelf" benefits. The Handidrive handbook gives full details! Get your copy now . . . free of charge, of course.

## 3 plans to help you select and order simplified HANDIDRIVE pre-engineered units

**"Do-It-Yourself" Plan** — Determine your conveyor requirements, then select stock units from Handidrive handbook.

**"Recommendations-Requested" Plan** — On your request, a Standard specialist will advise you on installation of a custom-tailored Handidrive conveyor

**"Leave-It-All-To-Standard" Plan** — Standard's staff of experienced engineers will work out your handling problems of a more complex nature.

**STANDARD**
GRAVITY & POWER CONVEYORS
*Sales and Service in Principal Cities*
OVER 50 YEARS
of conveyor experience

STANDARD CONVEYOR CO.
North St. Paul 9, Minn., Dept. EE-5
Please send me a free copy of your new Handidrive handbook.

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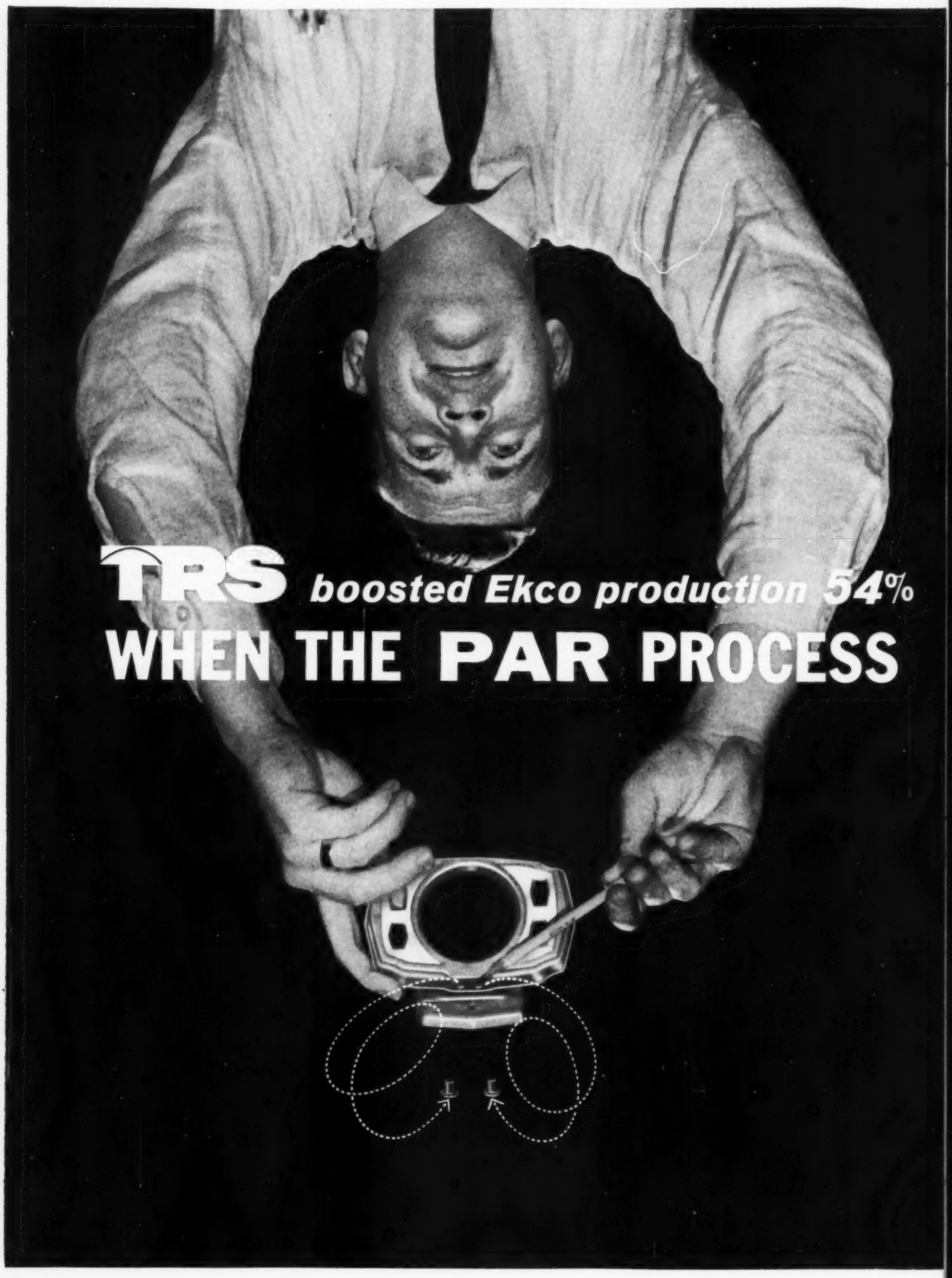
Circle 678 on Page 19


TRS boosted Ekco production 54%
WHEN THE PAR PROCESS

**For Ekco Products Company,** attaching wall brackets to their Autoyre® soap dishes and glass holders meant hand-assembling components with solid aluminum rivets in position, then placing the assembly in a die which required two strokes to clinch the rivets. This slow process, with lots of hand work, became a serious handicap when production demand started to climb. Obviously, a better method had to be found.

Automatic riveting, with semi-tubular rivets, would offer real savings. But riveting from the front was blocked by a flange on the product, and riveting from the back left the rivet clinches visible which lessened the attractiveness of the finished product.

There the problem stuck, until the TRS engineer — applying the PAR Process — suggested a new viewpoint. Working with Ekco engineers, he proposed riveting the assembly from the back but with the rivets fed upside down, so that their heads would be visible as required for good appearance. To accomplish this, he designed a special flat head rivet which could be fed and set in this manner with a standard TRS machine.

The change jumped daily production volume by 54%, without loss of product quality or appearance values.

**THE MACHINE PAR PROCESS PRESCRIBED** was a standard TRS Model 103L single-drive riveter. Designed to set flat head rivets of the type used in Ekco glass holders and soap dishes, it feeds them into the riveting position resting on their heads. For Ekco, the machine was fitted with a special loading fixture to position the parts of the assembly, and an air-operated pusher to eject the finished units.

# STOOD RIVETS ON THEIR HEADS

**FIND OUT what the PAR Process can save you**

**PAR** stands for **P**roduction **A**utomated **R**iveting. Its objective is cost reduction and increased production rate. It involves a careful study of the complete assembly operation by TRS engineers and your own production men . . . an organized search for opportunities to eliminate or simplify and speed-up steps in the assembly.

An invitation to conduct the PAR Process study in your plant is almost certain to bring you benefits such as those produced for many prominent manufacturers.

**Benefits Like These:** Often, the PAR Process has led to better integration and higher automation of the various steps in assembly and fastening. In many cases, it discloses ways to improve efficiency through minor modification of existing or standard equipment . . . or a simple change in materials or rivet design as in the case of Ekco. Sometimes, it reduces rejects and other costly elements in the assembly operations. Always, it considers not only human and equipment factors but also the important problems of using the most suitable rivet for the job.

**Why is PAR a TRS Process?** Because it involves procedures specially organized by TRS. It requires application by the specially trained and experienced TRS Engineers. It demands that unique advantages of TRS developments in rivets and riveting machines be available.

**Ask for a check of your operations.** Whether your fastening jobs are simple or complex, it can be worth dollars to you.

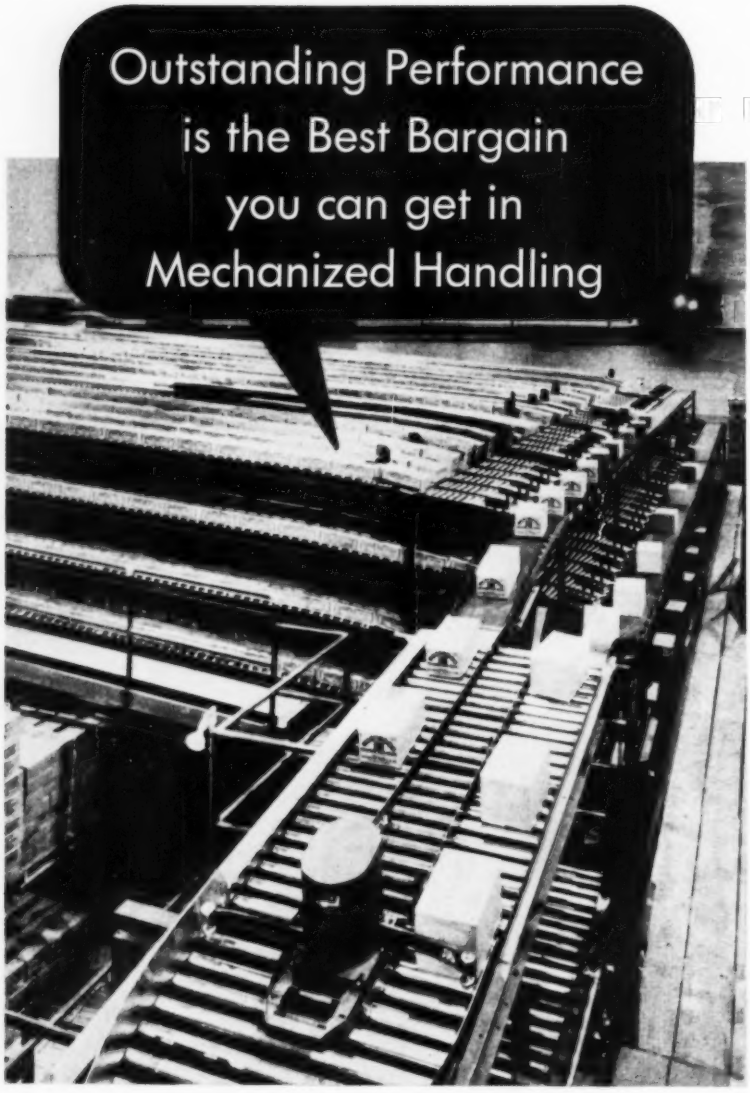
TRS

TUBULAR RIVET & STUD COMPANY

QUINCY 70, MASSACHUSETTS • TRS SALES OFFICES: Atlanta • Buffalo • Charlotte • Chicago Cleveland • Dallas • Detroit • Hartford • Indianapolis • Los Angeles • New York Philadelphia • Pittsfield • Quincy • St. Louis • Seattle. WAREHOUSE IN CHICAGO

See "Yellow Pages" for phone numbers.

*If it's a Tubular Rivet TRS makes it . . . and Better*




• Many plant operating people responsible for specifying conveying systems today are demanding equipment that is right *for them*—that will fully meet *their* individual requirements. They are looking beyond the price—to design and quality.

Mathews Engineers are giving these people a complete conveyer service—from the first proposal through installation—and equipment that is delivering outstanding performance.

| | |
|---|---|
| GENERAL OFFICES | MATHEWS CONVEYER COMPANY<br>Ellwood City, Pennsylvania |
| WESTERN DIVISION | MATHEWS CONVEYER COMPANY WEST COAST<br>San Carlos, California |
| CANADIAN DIVISION | MATHEWS CONVEYER COMPANY, LTD.<br>Port Hope, Ontario, Canada |

*Over Fifty Years of Leadership in Mechanized Handling*

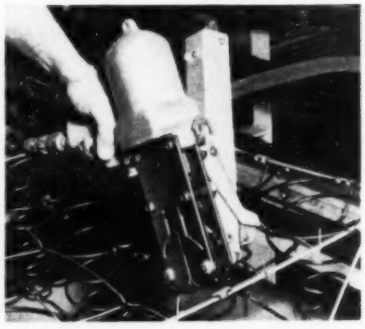
MATHEWS

Circle 680 on Page 19

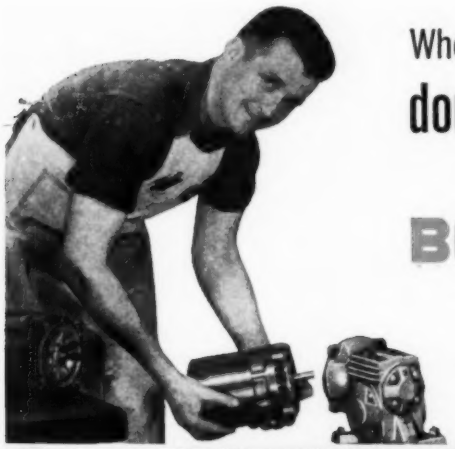

ager, Traveling Wave Devices Product Line; and **Allen C. Ashley** named project engineer, Magnetron Product Line, Electron Tube Div., Litton Industries. . . . **Frank G. Gustafson** appointed supervisor of Process Engineering Dept., Plant 7, Norton Co. . . . **Peter Rebechini** named chief engineer of the Aurora Works, Thor Power Tool Co. . . . **Walter R. Opel** appointed chief engineer of Cross Co. . . . **Dr. George E. Holbrook**—vice president, director, and executive committee member of E. I. du Pont de Nemours & Co.—elected vice president of Engineers Joint Council. . . . **Henry R. Odell** elected executive vice president of Beloit Tool Corp. . . . **Earl L. Pressel** named manager of manufacturing engineering for the Toledo Div., Electric Autolite Co.

## SPOTLIGHTING PLANTS

**Melpar Inc.**, subsidiary of Westinghouse Air Brake Co., has established a Special Products Dept. which will develop and produce electronic equipment and electrochemical materials. The company also plans to provide automation devices, special sound analyzers, and printed circuit layout, fabrication, and assembly services to the electronics industry. . . . **Ledex Inc.** is the new name of the former G. H. Leland Inc. . . . **Howe Sound Co.** has announced the acquisition of the outstanding stock of Peterson Machine Tool Inc. which will become a part of Sperry



PNEUMATIC tool automatically feeds metal clips from a magazine and clamps them on pairs of wires that are aligned in parallel. Designed primarily for the furniture and bedding manufacturing industries, the unit is suitable in other processes where wires must be joined permanently. Clips can be assembled in less than a second with the device, developed by Paslode Co., subsidiary of Signode Steel Strapping Co.



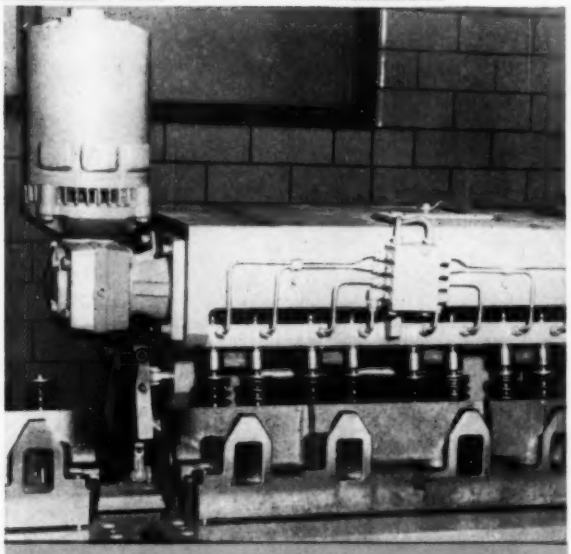
Where continuous automatic operations demand

# double insurance against downtime

the leading choice is standardized

## BOSTON Gear® SPEED REDUCERS

**NO DOWNTIME for motor repairs.** The standard end-mounted motor on BOSTON Gear RATIOMOTORS is easily detached by removing the bolts holding the motor to the gear unit flange. A spare motor can be attached, and operations resumed in a *few minutes*. Gear unit remains undisturbed, preserving alignment.



**BOSTON Gear Vertical Right Angle RATIOMOTOR drives the valve "popping" (final test) unit in a giant 29-station transfer machine for continuous automatic assembly of cylinder heads.**

**BOSTON Gear Horizontal Right Angle RATIOMOTORS drive magnetic belts which convey parts from lower storage bins to vibratory hoppers at start of 13-station, automatic assembly of roller skate wheels.**

BOSTON Gear RATIOMOTORS are the leading choice for all types of installations where downtime would be disastrous to production schedules. One reason is BOSTON Gear quality standards, which assure highest efficiency and extra service life of the gear unit. Another is BOSTON Gear design leadership like the detachable motor which permits continued operation with a spare, avoids downtime. Design around BOSTON Gear RATIOMOTORS for this *double* insurance against downtime. All types and ratios are *standardized stock* models, quickly available anywhere from over 100 BOSTON Gear Distributors. Boston Gear Works, 95 Hayward Street, Quincy 71, Massachusetts.

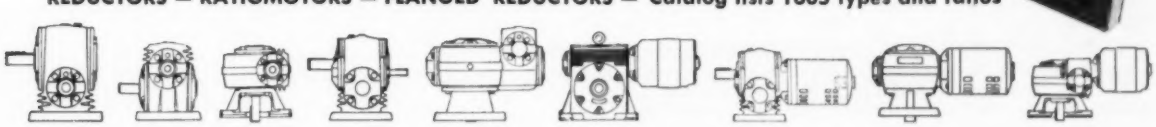
*Advt. copyright by Boston Gear Works*

*From Stock!*

**AT YOUR NEARBY BOSTON Gear DISTRIBUTOR**

— STANDARDIZATION PAYS —

**REDUCTORS — RATIOMOTORS — FLANGED REDUCTORS — Catalog lists 1605 types and ratios**

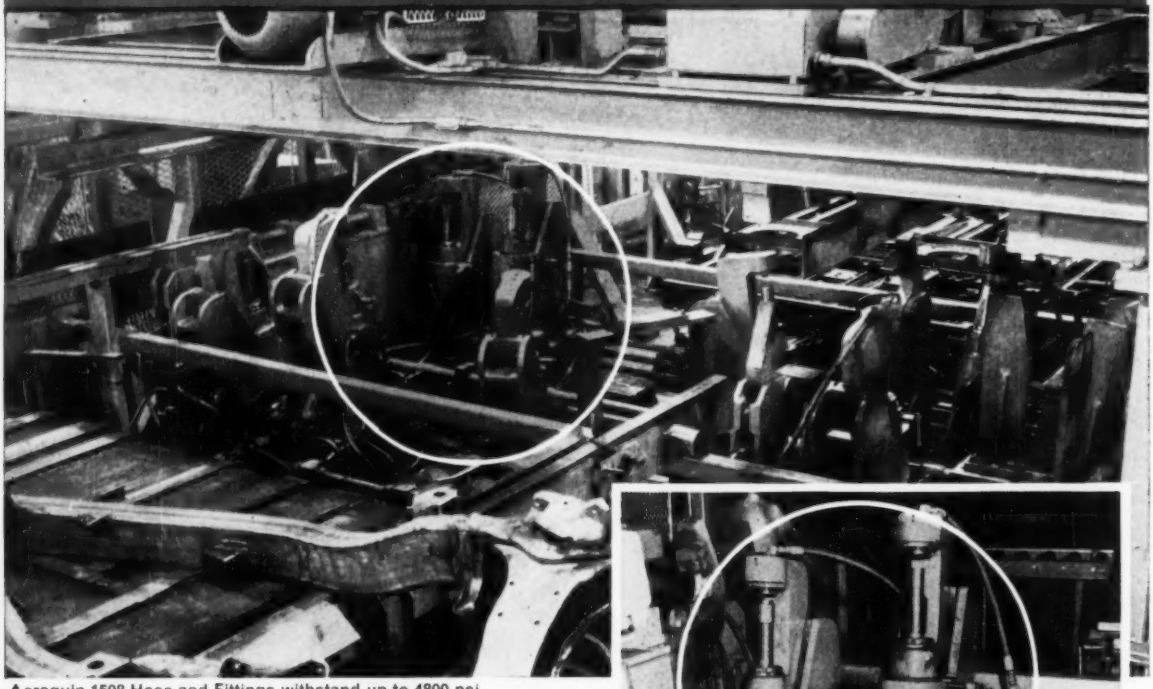


# For 4800 psi PRESSURE SURGES

## *Tool Engineer Specifies*

## Aeroquip *Hose Lines and Reusable Fittings*

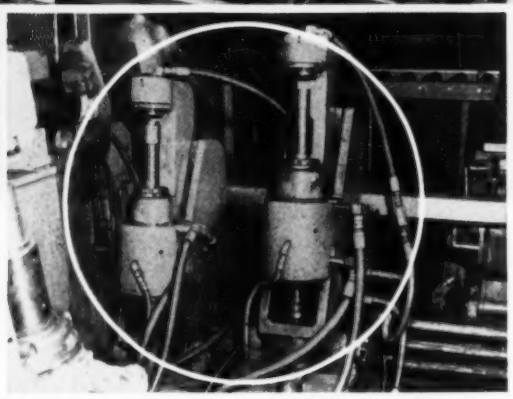
**From job report by large automotive plant producing auto frames and stampings**



Aeroquip 1508 Hose and Fittings withstand up to 4800 psi on this body bolt piercing machine.

The experience of this tool engineer has proved that a bulk stock of Aeroquip Hose and Reusable Fittings can expedite the design and maintenance of automated production machinery such as automatic body bolt piercing machines. In this application Aeroquip Very High Pressure Hose, under constant flexing and pressure surges up to 4800 psi, helps avoid down-time and keeps production running smoothly.

When infrequent Aeroquip Hose replacements are required they can be made on the job, quickly, easily and with minimum down-time. Hose can be cut as needed, no special tools are required. Fittings can be reused. Result—fewer and briefer interruptions to work flow.



Your Aeroquip Distributor is a fluid line specialist. He will give you a copy of our industrial Catalog No. 204 and explain why you are in good hands when you consult with Aeroquip. Call him. His telephone number is in the "Yellow Pages" under "Hose."

Aeroquip is so easy to use—your inventory is just a few feet of hose and a handful of fittings.

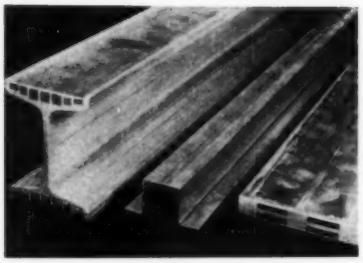
STANDARDIZE ON Aeroquip

REG. TRADEMARK

**AEROQUIP CORPORATION, JACKSON, MICHIGAN**

INDUSTRIAL DIVISION, VAN WERT, OHIO · WESTERN DIVISION, BURBANK, CALIFORNIA
AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN CANADA, U.S.A. AND ABROAD



VIBRATION damping characteristics of aluminum structural members have been improved with cellular construction shown. Each cell contains a steel insert separated from the cell walls by a viscoelastic damping material. Design, originated by Barry Controls Inc., provides minimum response of members to vibration. Principle, in modified laminar form, is said to be applicable to electrical circuit board, chassis, and relay construction.

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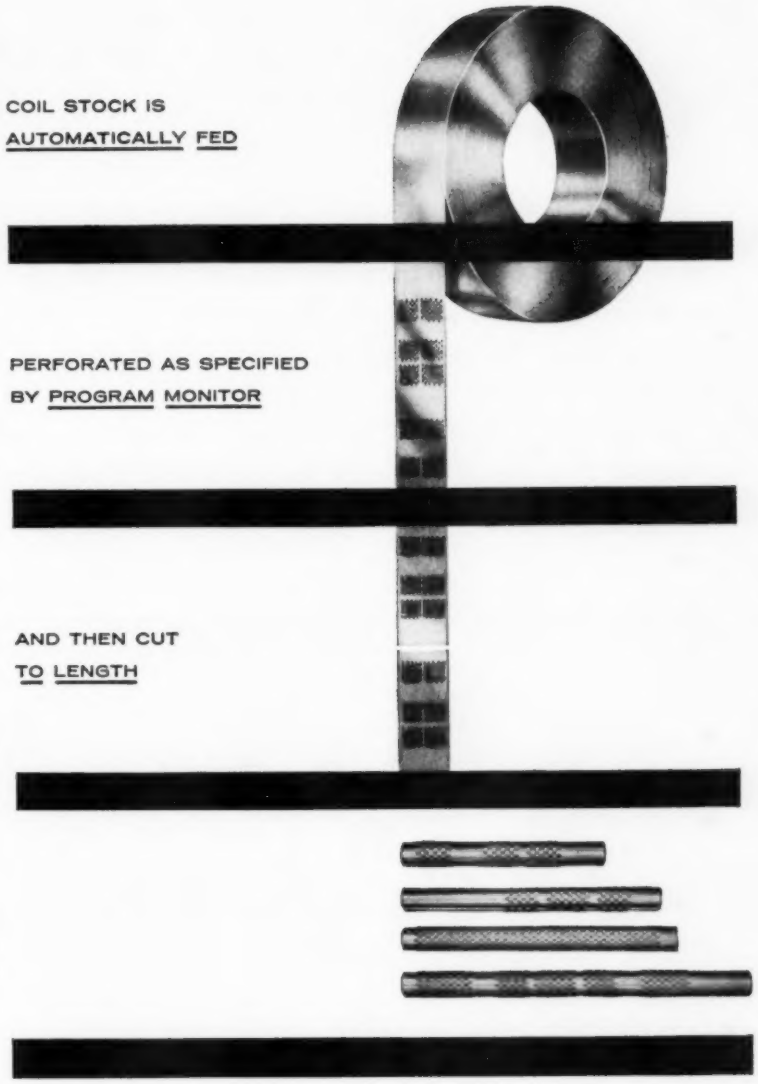
Products Co., a division of Howe Sound Co. . . . **Ardwin Microlab Inc.** has established a new department for the design and production of electronic counting devices for laboratory and industrial use. . . . **Edwin L. Wiegand Co.** has acquired Radcor Inc., a company recently formed to design and produce electric infrared ovens, low-temperature furnaces, radiant space heaters, fluid heat transfer systems, and asphalt plant heating equipment. . . . **Electronic Counters Inc.,** formerly a division of Potter Instrument Co., has occupied a new manufacturing plant in Syosset, Long Island, N. Y. . . . **Wean Equipment Corp.** and **McKay Machine Co.** have completed an agreement whereby McKay will serve as sales representative to the metalworking industry for Wean Equipment. . . . **Powers Regulator Co.** has acquired control of Grover Co. through stock purchase. The new acquisition will become a subsidiary of Powers Regulator and is a manufacturer of pneumatic tube systems. . . . **Computer Control Co. Inc.** has formed a new subsidiary, Electropac Inc., to augment production facilities of the parent company. . . . **Computer Systems Inc.** is building a 30,000 sq ft plant in Monmouth Junction, N. J. The new facility will house research and development, production, and administration organizations. . . . **Electronic Engineering Co.** has purchased Anaheim Electronics Co. Inc., manufacturer of electronic program control devices which are employed as components in automa-


**PROGRAMMING WITHOUT TAPE WITH ONE SET OF TOOLS**

Skip punching device, actuated by a repeating type counter, programs production of automotive muffler tube blanks in standard V & O inclinable press. Auxiliary counter controls blank cut-off. Varying perforation patterns are achieved with one set of tools. Integrating standard type mechanisms such as these to effect cost reduction illustrates the keen abilities that Emhart press experts can apply to your work improvement projects.

Emhart Manufacturing Co.
Hudson Div., Hudson, N.Y.
Formerly V & O Press Div.

**EMHART**

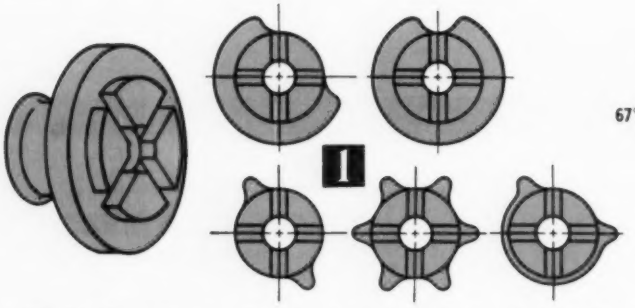


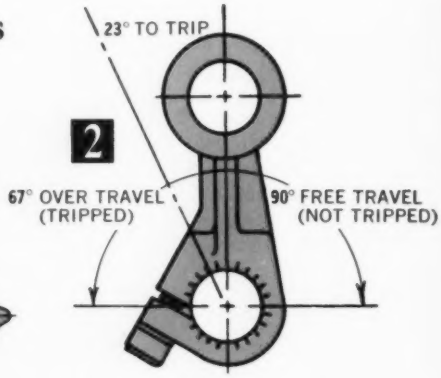

Circle 683 on Page 19

# The SL2 snap-lock•Newest NAMCO Machine Life Limit Switch

Snap-Lock Limit Switches, developed by National Acme to meet rigid specifications, have become industry's standard for reliable "machine life" service. Latest and most advanced in the complete line is the SL2. Built with machine tool precision and ruggedness, it will give millions of fast, accurate contacts. Furthermore, it is water and oiltight and can stand the bruising conditions imposed by heavy-duty machine applications. You owe it to yourself to closely examine the *combination* of performance characteristics that assure completely reliable limit switch performance under the most extreme operating conditions.

## Closely Check These Outstanding Features




**1. Flexible Operation . . .** To meet the requirements of any application, standard cam blank (above, left) can be cut into a wide variety of configurations including those shown. Interchangeable, these cams provide positive control of contact sequence; permit tailoring switch performance to individual jobs.

**2. Ample Overtravel and By-pass . . .** Sixty-seven degree overtravel . . . 90° by-pass . . . 180° arc.

**3. Clockwise or counterclockwise motion . . .** Converting from clockwise to counterclockwise motion takes but a few seconds.

**4. Light Operating Pressure . . .** Tripping action requires only 12½ pounds at 1½ inch radius . . . 50% less than previous models. Overtravel reduced so as to require only 8 pounds at 1½ inch radius.

**5. Shock-proof Design . . .** Positive mechanical lock mechanism withstands shock and vibration.

**6. Fast Contact Action . . .** High make-and-break contact speed permits use in unusual applications.

**7. High Contact Pressure . . .** Contact bounce minimized by use of new contact material that permits 15 oz. contact pressure.

**Write for Bulletin EM-SL60 containing complete detailed information**

**National Acme**

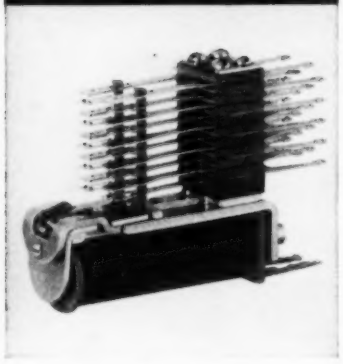
The National Acme Company
196 E. 131st Street
Cleveland 8, Ohio

**Sales Offices: Newark 2, N.J.; Chicago 6, Ill.; Detroit 27, Mich.**

*Circle 684 on Page 19*

NAMCO
SNAP-LOCK
SWITCH
SL2
VOLTS AC DC
AMPERE RATING
125 20 5.0
250 15 1.5
480 10
600 5.0
THE NATIONAL ACME CO.
CLEVELAND, OHIO
MADE IN U.S.A.
PAT. PENDING
NAMCO
SL2

"Telephone Quality"
Stromberg-Carlson
RELAYS



...to meet your electromechanical switching needs

These are the very same twin-contact relays proven outstandingly successful through many years of precise, exacting operation in the telephone industry.

The following regular types are representative of our complete line:

**Type A:** a general-purpose relay with up to 20 Form "A" spring combinations.

**Type B:** a gang-type relay with up to 60 Form "A" spring combinations.

**Type BB:** accommodates up to 100 Form "A" spring combinations.

**Type C:** two relays on the same frame. A must where space is at a premium.

**Type E:** same characteristics as the Type A, plus universal mounting arrangement. Interchangeable with many other makes.

Types A, B and E are available in high-voltage models (insulation withstands 1500 volts A.C.) for test equipment and other high-voltage applications.

Details and specifications are in our complete relay catalog, available on request. Write to Telecommunication Industrial Sales.

STROMBERG-CARLSON
A DIVISION OF GENERAL DYNAMICS
111 Carlson Road • Rochester 3, N. Y.

Circle 685 on Page 19

tion and automatic process control equipment.

## MEETINGS AND EVENTS

May 9-12—

**Instrument Society of America.** Second ISA Instrument-Automation Conference and Exhibit of 1960 will be held in Civic Auditorium and Brooks Hall at San Francisco. Additional information is available from ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

May 9-13—

**American Foundrymen's Society.** Castings Congress & Exposition to be held in Convention Hall, Philadelphia. For details contact AFS headquarters, Golf and Wolf Roads, Des Plaines, Ill.

May 11-13—

**Material Handling Show & Packaging Cavalcade.** Third Western Regional Show sponsored by American Material Handling Society, Los Angeles Chapter, will be held in Great Western Exhibit Center, Los Angeles. Information is available from A. B. Perkins, 2807 Sunset Blvd., Los Angeles 26, Calif.

May 12-14—

**American Institute of Industrial Engineers.** Eleventh Annual National Conference and Convention to be held at Sheraton-Dallas Hotel, Dallas. Details on request to AIIE, P.O. Box 914, Irving, Texas.

May 19-21—

**Operations Research Society of America.** Annual meeting to be held Statler Hotel, New York. For more information contact ORSA headquarters, Mt. Royal & Guilford Ave., Baltimore 2, Md.

May 22-26—

**National Office Management Association.** 41st International Conference and Office Exposition is scheduled for Queen Elizabeth Hotel and Show Mart in Montreal, Canada. Information is available from NOMA headquarters, 1931 Old York Rd., Willow Grove, Pa.

May 23-25—

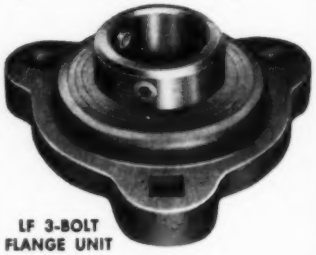
**National Telemetering Conference.** Cosponsored by IRE, AIEE, IAS, ISA, and ARS, conference will be held Miramar Hotel, Santa

SEALMASTER

"L" SERIES

A HIGH QUALITY LINE OF MALLEABLE HOUSED BEARING UNITS AND BEARINGS AT A COST THAT IS WARRANTED ON YOUR MACHINE!

ECONOMY PERFORMANCE QUALITY



LF 3-BOLT FLANGE UNIT

Available in pillow blocks and two or three bolt flange units for flush or recessed mounting. All units in the "L" Series available with the new SEALMASTER contact type seal.

LP PILLOW BLOCK

LF FLANGE UNIT LFT FLANGE UNIT

WRITE FOR BULLETIN 359

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22 RIDGEWAY • AURORA, ILL.
PLANTS LOCATED IN: LOS ANGELES, CALIF. CLARKSDALE, MISS. • BELLEVILLE, ONTARIO

Circle 686 on Page 19

Monica, Calif. For information contact R. E. Colander, Bendix Pacific, 7250 Laurel Cyn. Blvd., N. Hollywood, Calif.

May 24-26—

**Institute of Radio Engineers.** 7th Regional Technical Conference & Trade Show to be held Olympic Hotel, Seattle. Information is available from Dr. Frank Holman, Boeing Airplane Co., 10708 39th Ave. S.W., Seattle 66, Wash.

June 5-10—

**American Society of Mechanical Engineers.** Semiannual meeting and aviation conference will be held Statler-Hilton Hotel, Dallas. Details are available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

June 5-10—

**Society of Automotive Engineers.** Summer meeting scheduled for Edgewater Beach Hotel, Chicago. For more information contact SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

June 6-8—

**Material Handling Institute.** New England show to be held Commonwealth Armory, Boston. Educational meetings will be sponsored by the American Material Handling Society. More information is available from W. L. Redding, Hanson & Shea Inc., One Gateway Center, Pittsburgh 22, Pa.

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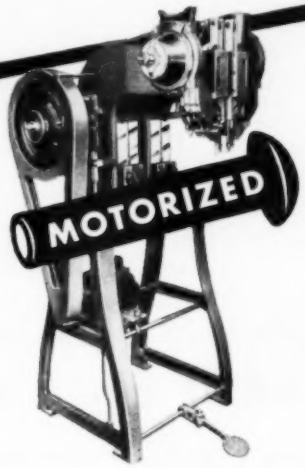
*"I don't know, he was here a minute ago . . ."*


# Why *Chicago Rivet* Offers TWO METHODS for Clinching Semi-Tubular Rivets

It is part of a widening service based upon industry's recognition that an assembly held together by semi-tubular rivets has great inherent strength and is usually lowest in production cost.




The Chicago Rivet MOTORIZED AUTOMATIC RIVET SETTER produces a sharp, solid blow that immediately upsets the tubular section. This method is used on 95% of all applications involving metals or non-fragile materials.

The Chicago Rivet AIRPOWERED RIVETER produces a cushioned, shock-free clinch on a tubular rivet, permitting riveting of fragile and uneven materials. This method has greatly widened the use of semi-tubular rivets.

**FOR YOUR FILES**

RIVET CATALOG describes 1388 standard tubular and split rivets and 25 single and multiple motorized automatic rivet setters.

AIR-POWERED RIVETING catalog contains description and specifications of 8 single and multiple riveters—also rivet setters designed for automated operation.

Why not let Chicago Rivet Fastening Engineers tell you which system is best for you. No obligation.

**MOTORIZED**
Line includes automatic single, multiple and automated setters.

**AIR-POWERED**
Line includes automatic single, multiple and automated setters.

*Chicago Rivet*
**& MACHINE CO.**
943 So. 25th Ave., Bellwood, Ill.
(Chicago Suburb) Branch Factory:
Tyrone, Pa.




Circle 687 on Page 19

# New Tally Tape Console cuts punched tape preparation time by 600% on Hound Dog missile

Last fall, the first production model of the new Tally Tape Console was delivered to North American Aviation's Missile Division to speed the preparation of punched paper tapes. The tapes in turn program both production and preflight missile checkout systems on SAC's Hound Dog missile.

Before the Tally Tape Console was installed North American Missile Division engineers took 30 hours to make and absolutely verify a 400-foot programming tape. To make and absolutely verify a duplicate copy of the tape required an additional 75 minutes.

## The Results

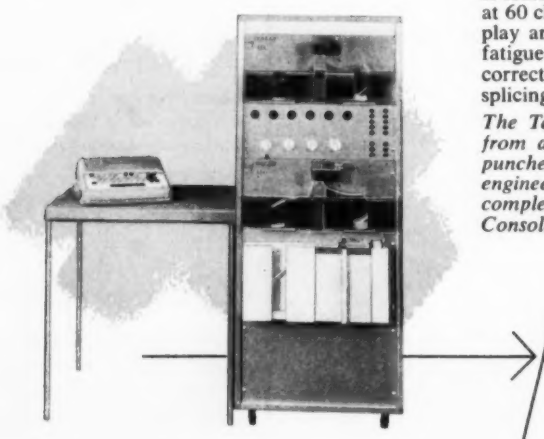
Now, North American Missile Division engineers using the new Tally Model 150 Tape Preparation and Editing Console make 400-foot tapes in three to four hours. Duplicate tapes are made in only 37 minutes. And Tally tapes are *guaranteed* error free.

Tally/Seattle is pleased to have played a significant role in North American's pace setting GAM-77 program which took only thirty months from design to flight of production models by SAC crews.

## Tally's Tape Console simplifies and automates punched paper tape production

It features tape-to-tape duplication and verification at 60 characters per second. A keyboard visual display and shift register reduces error and operator fatigue in both punching and verifying modes. Tape corrections can be made without overpunching or splicing.

*The Tally Tape Console is another new product from a creative engineering team specializing in punched paper tape technology. Your nearby Tally engineering representative can provide you with complete technical information on the Tally Tape Console or you may write directly to Dept. 06.*



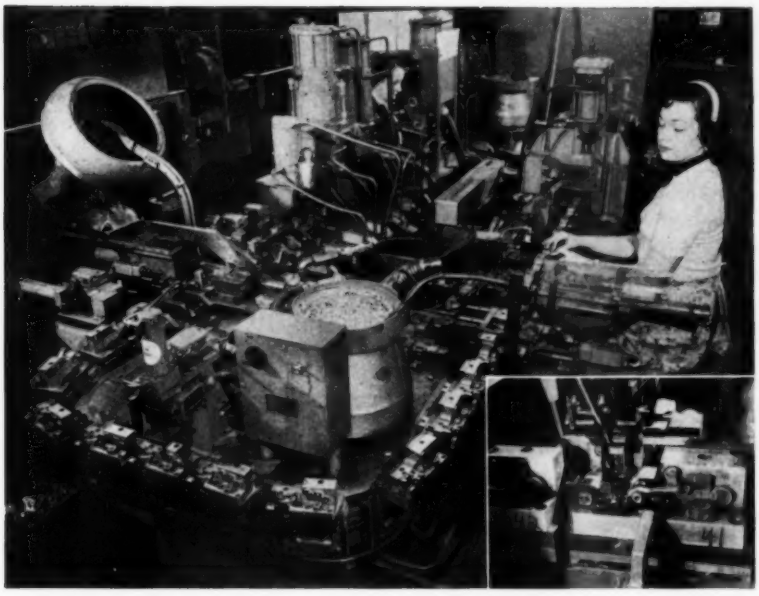
TALLY

REGISTER CORPORATION

1310 Mercer Street
Seattle, Washington
Phone: MAin 4-0760

Circle 688 on Page 19

By JAMES C. KEEBLER Managing Editor



Components for distributor parts are machined and assembled in an automated 60-station machine at Ford's Ypsilanti plant. Riveting is part of the cycle, automatically performed in a dual-head setting machine in the back right-hand area. Photo inset in lower right shows close-up of riveting heads in contact with a fixture.

# Set to Assemble

SPRING conference season is a busy time in which the joiners of industry are privileged to attend a host of technical meetings in an effort to keep pace with what's going on in the world.

This pursuit of knowledge provides an opportunity to see some of the world too, for the list of meetings of interest to the automaters covers a wide geographical territory: The SAE National Production Meeting and the joint ASME, IRE, and AIEE Conference on Automatic Techniques were in Cleveland; the AMA Packaging Exposition in Atlantic City; the ASLE annual meeting in Cincinnati; the ASTME in Detroit; the AWS in Los Angeles, the ISA Southeastern Conference in Pensacola, Fla.; and others are scheduled; the National Association of Relay Manufacturers are at Oklahoma State University; the ISA in San Francisco; the AIIE in Dallas; and ASME Production Engineering Conference in Milwaukee.

As a technical journalistic columnist it would be a pleasurable duty to report in depth on all of these assemblages, but some time must be spent watching the store, so it is necessary to forego a few toastmasters' jokes and hotel dessert cookies for the mundane chores of making magazines.

As a matter of practicality it becomes necessary to cover some matters only by extending best wishes to those who labor to further the educational level of the industrial world, and bid the reader to watch the Meetings and Events columns of AUTOMATION so as not to miss out on a technical conference of particular interest.

### More Organizations

We would be derelict in our duties not to also mention a couple other shindigs that transpired. The General - Purpose Machine Tool Standardization Group met in Detroit. This group comprises representatives from builders and users in major industries such as automotive, aviation, electrical, and appliances, plus government men and representatives of the NMTBA. They've set out to tame down the dimensioning of machines that do milling, grinding, drilling, and turning. The tool mounting and related surfaces that are their concern include table heights, tee-slots, and spindle tapers.

Chairman of the Co-ordinating Committee for this effort is R. L. Witsche, general supervisor of mechanical engineering, manufacturing research department International Harvester Co. The basic thinking here parallels that of the building block standards for transfer machines.

### Purdue Conference

The big event that hit closest to the hearts of those responsible for achieving more automatic operations, however, was the Fourth Conference on Manufacturing Automation at Purdue. To those who recognize the need to supplement their education, experience, and magazine reading with some educational conferring, this annual program represents a good opportunity to get a well rounded approach without spending three months on the road.

In fact the newly formed Manufacturing Engineering Council, which had its origins in previous such conferences, promises to further simplify the problem of conferring with the right people by continued efforts to cater to the unique needs of that new breed of engineer who is responsible for specifications relative to production processing. The Council has pledged support to this series of conferences.

By the accepted standards of measurement, this year's Purdue

## A COORDINATED ELECTRICAL SYSTEM IS THE KEY TO IMPROVING PRODUCTIVITY AND PROFITS

Westinghouse is ready now to help you plan economical steps to automatic production . . . to achieve your goals without over- or under-automating.

For many manufacturers, Westinghouse *Progressive Automation* has already proved a completely practical method of gaining improved product quality through step-by-step control of operations . . . a long-term plan with minimum capital cost for each step.

**Now . . . automation step by step:** Step-by-step automation can start with the modern Westinghouse controls, motors and drives at work in plants today. Each of these components was developed to achieve an immediate production objective . . . to control a single machine, a conveyor line or an entire installation. With this plan you then add other Westinghouse coordinating controls, all of which are compatible with those previously installed.

**Benefits of long-term planning with minimum investment:** First, you are meeting current production needs . . . improving productivity and/or raising product quality. Second, you are building a coordinated system . . . always ready for the next step in your long-range plan for automation. Your goal may eventually be overall production coordination under one master device . . . the Westinghouse industrial control computer.

Westinghouse—your one source for computers, controls and subsystems, and all equipment such as transformers, switchgear, motors, gearing and drives—will assume complete system responsibility.

# WESTINGHOUSE PROGRESSIVE

WESTINGHOUSE PROGRESSIVE

AUTO

# AUTOMATION

MATION

**Examples of Progressive Automation at work:**

**In the primary metals industry,** installations of Westinghouse PRODAC* (programmed digital automatic control) have improved product quality and mill efficiency. This system has made possible automatic control of rolling mill functions, as well as monitoring all phases of the product and process by data accumulation systems.

Westinghouse industrial control computers are now being integrated with PRODAC to transform rolling mill equipment into a completely automatic unit. Three such systems are on order and underway.

**In the paper industry,** PULSETTER*, an automatic digital control system, makes possible new standards of accuracy and product quality in paper production.

**In the chemical processing industries,** Westinghouse provides OPCON* which experiments, then finds and controls optimum production efficiency.

Let us know your objectives. Westinghouse is prepared to work out a long-range plan of progressive automation to provide your plant with the controls and other devices necessary to improve production. We are prepared to recommend, furnish, install . . . and maintain . . . all equipment to fulfill that plan. Call your local Westinghouse representative for complete information on *Progressive Automation.*

*Trade-Marks

**Westinghouse Progressive Automation can help you Power-Up for Profit . . . Electrically**

J-96139

YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV ALTERNATE FRIDAYS



Circle 689 on Page 19

Conference was acclaimed the best yet. Although a wide variety of industries was represented, there was also a good contingent of automakers registered. Spokesman for the industry from the stage was Chrysler's staff master mechanic, K. C. Butterfield, who led off the panel "Engineering Costs—Who Pays?"

By noon of the second day everyone was well enough acquainted with the other 218 conferees that one automaker ventured the opinion that Detroit is as much as five years ahead of other manufacturing establishments when it comes to automating. Another admitted that although machining operations are pretty far advanced, automated assembly is in its infancy, and Detroit is moving toward maturing its automatic assembly techniques.

Meanwhile back at the ranch, we've heard from the Tubular and Split Rivet Council whose agents have staked out autodom as a likely place to corner examples of automating the riveting process. They must have been reading short stories from the 1960 SAE Handbook where one of the ten listed advantages to riveting is: "Rate of assembly is high and due to its simplicity, riveting lends itself to automation."

By whatever means of sleuthing they employed, the writeup is of particular interest because it reveals the highly co-ordinated product and process design efforts of the automakers. The big emphasis on fasteners today is on "in place" cost. The corporate effort must not only consider the cost of the fastener itself but also the cost of placing and securing it in the assembly.

On the basis of this type of analysis the Rivet Council has observed that the automakers are using rivets by the tens of millions to fasten heaters, horns, window regulators, instrument clusters, clutches, headlamps, and such parts.

### Standards Set

So as not to be running off in all directions at once the automakers are keeping track of the rivet designs employed with the idea in mind that the number of different diameters and lengths stocked should be kept to a minimum. Chrysler is reported to be currently using 34 types of steel tubular rivets and ten types of brass rivets. Though this provides a large selection, it is a more realistic variety than previously handled and achieves savings in inventory and purchasing.

Ford has a similar program. Standards personnel tabulate every fastener used in assembly lines. Semitubular rivets are listed by diameter, length, head type, and tolerances. Comparisons are made with standards established by suppliers, ASA, and SAE.

### Integrated Operations

Even though riveting in the auto industry never was like that known to Rosy the Riveter in World War II, the familiar pedestal-mounted machines are taking on some new looks. Instead of fumbling some parts together by hand, placing a rivet, and shoving the whole thing between the anvils of a single-station machine, the more modern engineered setups call for automatic handling of workpieces into and out of multiple-head riveting stations which provide for automatic orienting and feeding of rivets.

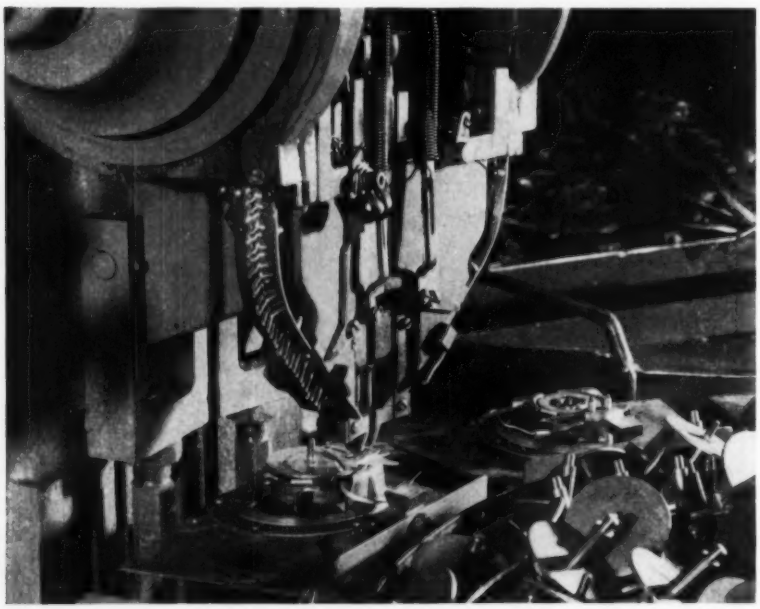
Automatic control systems interlock the riveting cycle with that of the other actions of the machine. Different manufacturing engineers have individual preferences for electromechanical or pneumatic actuation.

In some assembly problems where the riveting is one of the few operations not performed manually, large rotary dial tables are provided with multiple workstation nests and mounted in front of a pedestal type riveter. The hand operations are performed at various positions around the dial and the riveting cycle initiated by dogs or levers mounted on the workstations.

The more complex assemblies with other automatic workstations use basic chain-around-table or dial transfer systems and bench type riveters mounted at the appropriate workstation. Single or multiple-head units are used and cycled to deliver and set the necessary rivets when the assembly fixture is aligned in the workstation.

### Interlocked Control

Special equipment builders and rivet machine manufacturers have developed the necessary control interlocks to be certain the riveting machine has cycled properly. These sense and signal any malfunction that might cause trouble. These factors confirm the SAE handbook's statement. Riveting can be an efficient automated operation in the assembly process.



Assembly operations on parts for auto horn are accomplished on 12-station rotary table arrangement at Ford. Two rivet setters integrated into the equipment cycle as a unit, orienting, feeding, escaping, and setting rivets.

## 1000 strokes a minute!

Now in daily operation at the Truarc Retaining Rings Division of Waldes-Kohinoor, Inc., of Long Island City, New York, this new Bliss High Production Press is running at the blurring speed of 1000 strokes a minute, hour after hour, day after day. First of its kind, this completely new press has a revolutionary counterbalancing system and massive, close tolerance construction that virtually eliminate vibration, even at this phenomenal speed. Could a press like this cut your parts cost...add to your profit picture? We'll be glad to give you the facts.

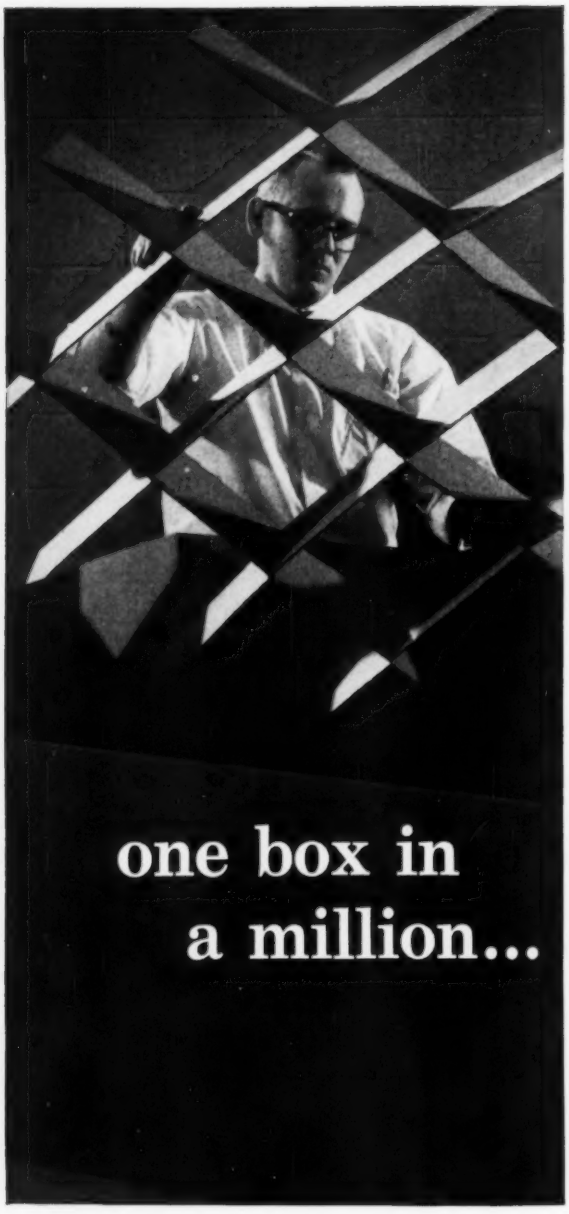
BLISS
SINCE 1857

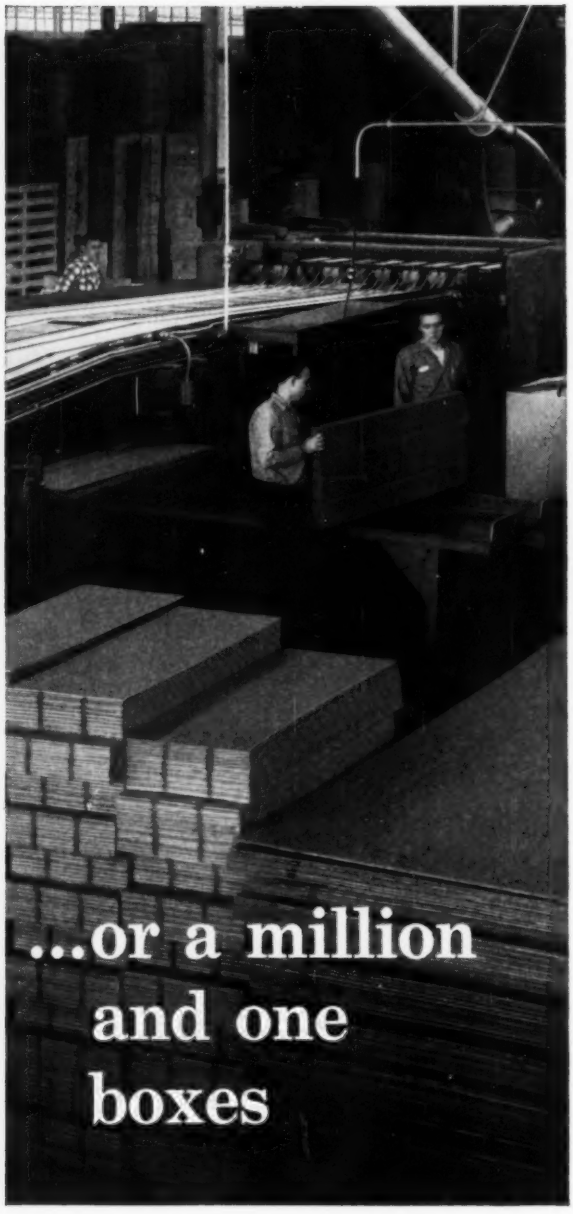
**E. W. BLISS COMPANY · Canton, Ohio**

*BLISS is more than a name—it's a guarantee*

**PRESSES • ROLLING MILLS • ROLLS • DIE SETS • CAN MACHINERY • CONTRACT MFG.**

*Circle 690 on Page 19*




Perhaps you need a completely new type of corrugated package, for a product that requires ingenious container design. If so, you'll benefit from Hinde & Dauch's *creative approach* to package engineering. Or maybe you use standard shipping boxes in great quantity. In that case, you can count on H & D's large volume capacity—more than six billion square feet per year—to keep you supplied for uninterrupted production.

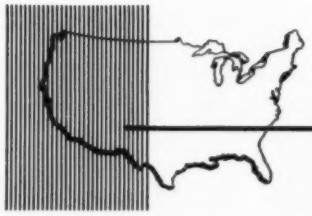
**Hinde & Dauch Division**

**West Virginia Pulp and Paper**

HINDE & DAUCH DIVISION, WEST VIRGINIA PULP AND PAPER, SANDUSKY, OHIO • 17 PLANTS • 42 SALES OFFICES

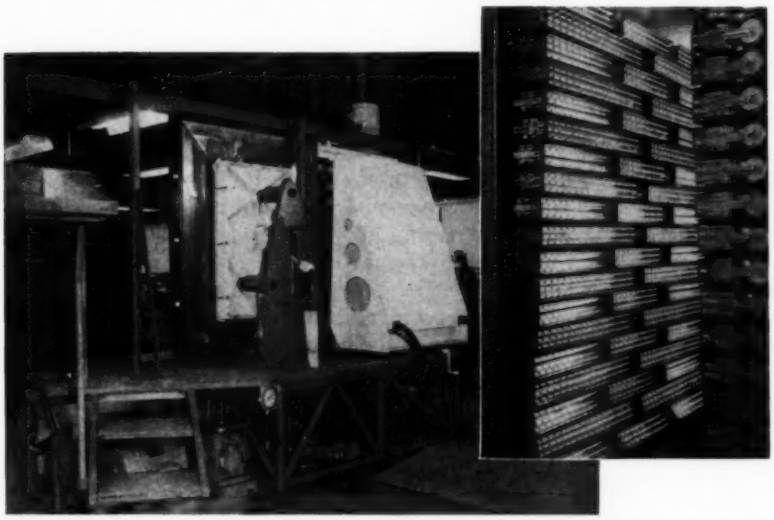


*Circle 691 on Page 19*



## western trends

By NORMAN LYNN
Los Angeles, Calif.



Radiant brazing process developed by Norair, a division of Northrop Corp., is used to effectively join stainless steel honeycomb core material to stainless steel skin panels. In this view of the brazing machine, a panel in its airtight envelope has been moved from between the banks of radiant brazing lamps on the right and is being held between chill forms on the left. Inset shows the two banks of radiant quartz lamps which can be energized and controlled selectively for brazing various panel shapes and sizes. The lamps provide heat up to 6000 F and are controlled by sensing devices installed inside the honeycomb panels.

# Radiant Brazing

INDUSTRY is constantly faced with the necessity of periodically upgrading its production methods, materials, or process equipment in order to satisfy changes in consumers' demands or to increase productivity to hold price lines. These changes are usually evolutionary—not revolutionary—in that only one phase of production must be changed at any one time to satisfy current demands.

However, the aircraft manufacturers on the West Coast have been swept up in a revolutionary change as the age of flight has progressed from subsonic riveted aluminum aircraft to space age Mach 1, 2, and 3 missiles and planes requiring welded stainless steel skins reinforced with honeycomb materials. Not only have the designs changed, but also the materials for making the products — entailing entirely new methods and equipment for production.

For example, since aluminum skin material cannot stand up under the high forces and temperatures created at Mach speeds, the aircraft industry has been forced to use metals in the stainless steel family, titanium alloys, and exotic metals in the columbium and molybdenum groups. However, the differences in weight between aluminum and these metals increases the weight of the aircraft structure, decreases the payload that can be carried, and ups the requirements for propulsion and accessory equipment.

To beat the weight problem and gain additional strength, aircraft manufacturers have developed the principle of honeycomb sandwich construction for flight panels. A typical construction would be a panel having a 17-7 PH stainless steel core with 0.025-inch cell size made of 0.0015-inch thick foil which is brazed to 0.020-inch thick 17-7 PH stainless steel skins.

### New Techniques Required

With the advent of the new materials and new types of construction, the manufacturers had to develop new methods and equipment to produce satisfactory products from them. Cutting and shaping the honeycomb materials produced a range of problems and led to the development of new techniques and equipment. Brazing the thin foil shapes to the stainless steel skins was even a greater challenge. Blanket heating methods were developed but were found to have many disadvantages. Furnace brazing methods have been found to be satisfactory. However, three to 12 hours are required in the furnace, and heat inequities in asymmetrical parts sometimes cause warping.

One of the companies working on the honeycomb brazing problem was Norair, a division of Northrop Corp. Their approach was to apply heat to the panels systematically so that as the weight and density of various areas of the panel changed, the applied heat could be changed. This led to the development of the radiant brazing equipment shown in the accompanying photograph. The process, representing a space age manufacturing breakthrough, is called Nortobraze, and was invented by Paul W. Warren of Norair's Manufacturing Research and Development Group.

In the brazing process, each stainless steel honeycomb panel is enclosed in an airtight metal envelope and is positioned between two banks of electronically controlled radiant quartz lamps. These lamps can pro-

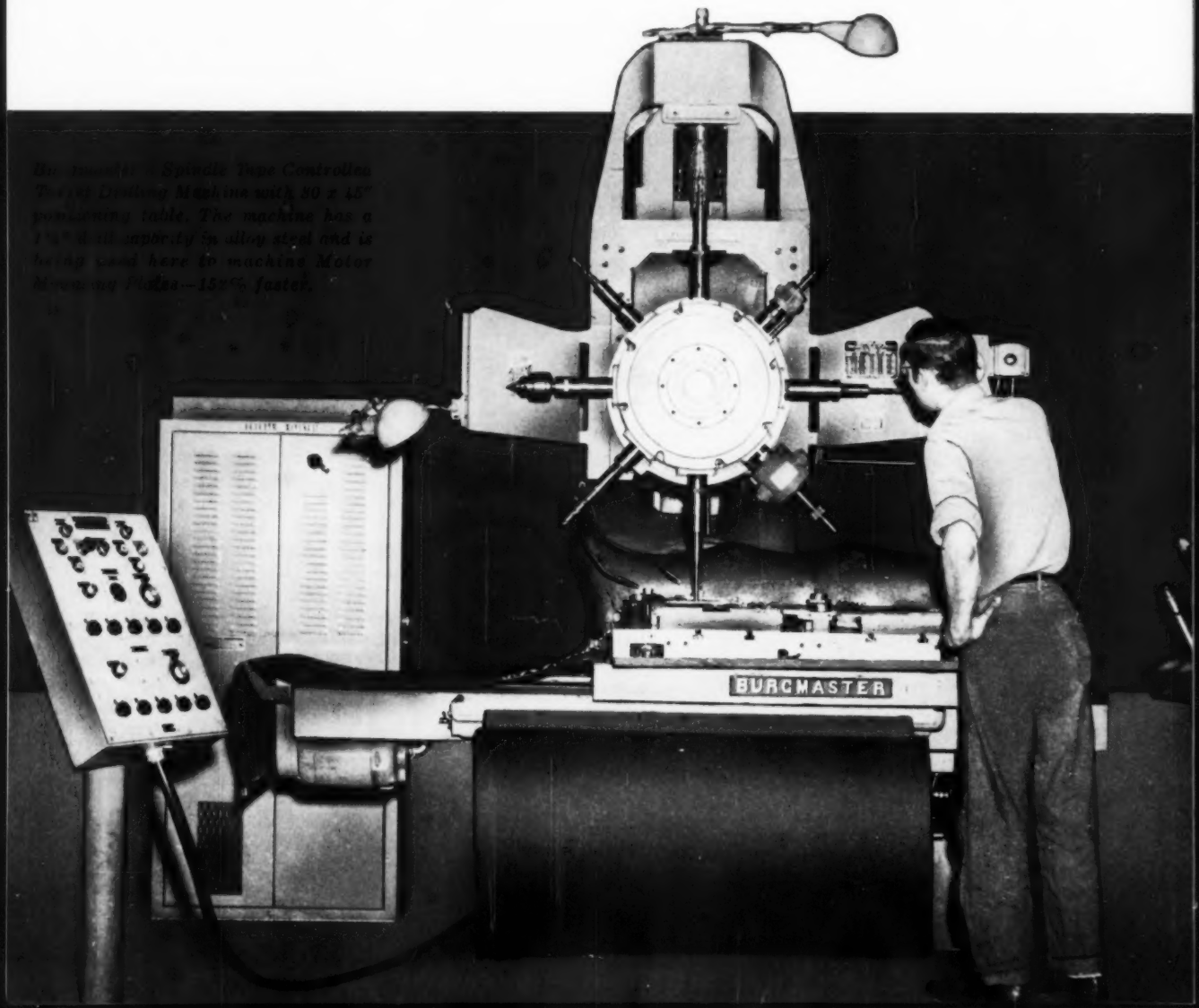
# BURGMASTER

## 8 Spindle Tape Controlled Turret Drilling Machines

### Maximum Flexible Automation

Although the Burgmaster is a standard machine, it is practically "obsolete proof." The standard adjustable controls permit rapid set-ups from one part to another which results in economical handling of small lots or high-production work. Only the tape needs changing and an engineering change in a part only means splicing in a new segment of tape. Some companies report 8 or 10 different set-ups per day. Expensive fixtures are eliminated and parts are held by simple clamps locating on plugs, in corners, etc. Generally a holding fixture is made on the Burgmaster in a sub-plate mounted on the table in a matter of minutes.

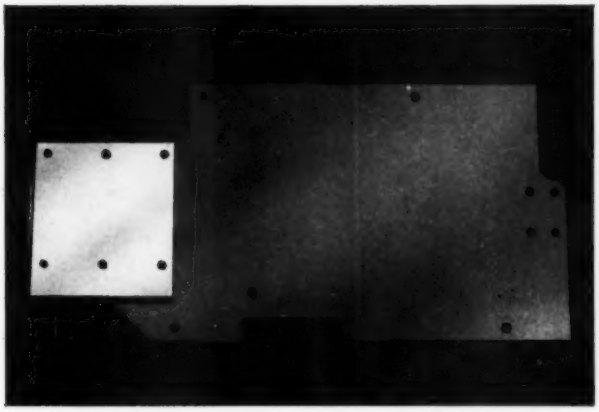
The machine is entirely automatic except for loading and unloading and all operations are carried out at their most efficient rate for high finish, precision, speed, and longest tool life. One man can operate two machines or perform other work such as inspection, deburring, and assembling.




*Burgmaster 8 Spindle Tape Controlled Turret Drilling Machine with 80 x 15" positioning table. The machine has a 1¼" drill capacity in alloy steel and is being used here to machine Motor Mounting Plates—150% faster.*

# Small Lot Motor Bases Produced 152% Faster at Jeffrey Manufacturing Co., Columbus, Ohio

Jeffrey Manufacturing Co., Columbus, Ohio, use their Burgmaster Tape Controlled Turret Drilling, Tapping and Boring Machine with a 30 x 45 positioning table to produce Motor Mounting Plates in lots of 6—152% faster. The Tape Controlled Burgmaster further eliminates the need for a $500 fixture that would be necessary to hold the ±.001" tolerances required. Parts are held by simple clamps and a total of 31 c'drilling, drilling, reaming and tapping operations are produced in the motor bases in 21 minutes each, floor to floor.



*31 operations including C-drill, Ream, Drill and Tap are performed in 21 minutes floor to floor in Motor Mounting Bases. Lot sizes 6 parts and tolerances of ±.001" hole centers are held on the 2 reamed holes.*

## Job Facts:

**Company:** Jeffrey Manufacturing Co., Columbus, Ohio.

**Machine:** Burgmaster 8 Spindle Tape Controlled Turret Drilling, Tapping and Boring Machine, 30 x 45 Positioning Table.

**Part:** Motor Mounting Plate.

**Material:** C-1020.

**Quantity:** 6 parts.

**Holding:** Simple U-clamps, and Blocks for drill clearance.

**Accuracy:** ±.001" Reamed Hole Centers.

**Former Time and Method:** 318 minutes 6 parts, including hand layout and drilling on standard drill press.

**Present Time:** 21 minutes each, 126 minutes total 6 parts.

**Production Increase:** 152% over former method.

**Advantages:** Increases production 152% and assures consistent, uniform accuracy. Eliminates the need for a $500 fixture. Economically handles small lot work.

## Important Machine Features:

1. Preselective spindle speeds.
2. Speed range: 20 speeds from 20 to 1700 RPM with 2 speed 10HP Motors—or 24 speeds from 70 to 2400 RPM with 4 speed 15HP Motors.
3. Preselective-Infinitely variable feeds.
4. Hydraulic feeds are automatically temperature compensated.
5. Positive hydraulic feed rates are Dial Calibrated.
6. Table automatically positions on 2 axes simultaneously.
7. Selective rapid approach and return—and preset Depth Stops.

**A Burg Tool representative will assist you in making a study of your work. There is one near you and there is no obligation.**

Write for Bulletin describing Burgmaster 6 and 8 Spindle Tape Controlled Turret Drilling, Tapping and Boring Machines. Thirty-minute 16mm sound film showing all Burgmaster Turret Drills in operation is available from any office without charge.

Circle 692 on Page 19

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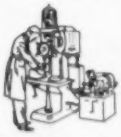
1C Manual Power Index ⅜" Capacity

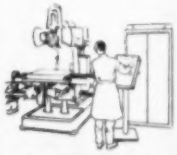
2B Manual Power Index ¾" Capacity

2BR Ram Type Radial Drill ¾" Capacity

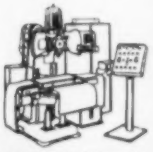


2BH Automatic Hydraulic ¾" Capacity

3BH Automatic Hydraulic 1½" Capacity



25AH Automatic Tape Controlled 1¼" Capacity



2BHT-3BHT Automatic Tape Controlled ¾" and 1½" Capacity

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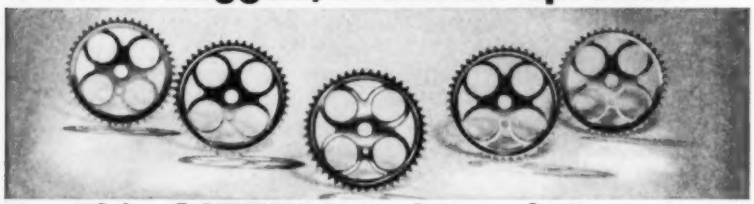
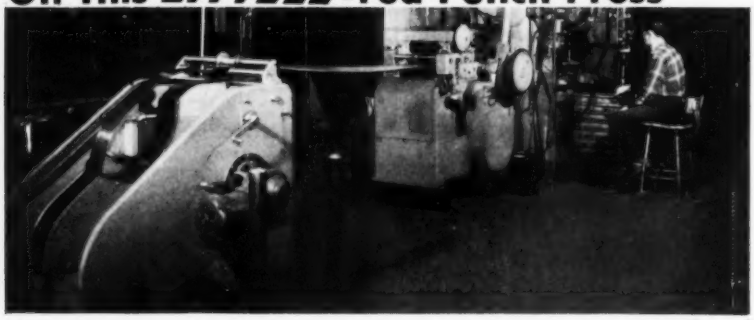
## Gets Its Rugged, Precision Sprocket



## On This *LITTELL*-Fed Punch Press



Stamping out sprockets for famous Schwinn Bicyles is *precision* stamping. The special high strength steel stock is perfectly conditioned for accurate work. Flat stock, free of coil curvature, reaches the die area at perfectly timed intervals. For sprockets and other vital parts, Schwinn achieves this straightening-feeding precision economically, using the Littell "HRP" self-powered, hydraulically driven feeding and straightening machine. The "HRP" will serve you as well.

### "HRP" is Versatile, Accurate, Convenient

The straightening-feeding cycle of the self-powered HRP unit is synchronized with the stamping cycle of the press by a single electrical connection. HRP units remove the coil curvature, and feed the straightened stock to the press or shear at precisely the desired speed. They feed from either side of the press, or from front to back. They can be positioned at special angles to produce specially shaped parts. Pulling an electrical plug disconnects the "HRP" from the press. Furthermore, the "HRP" can be easily moved from press to press by a lift truck. Facts in Bulletin B-10.

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vide heating temperatures up to 6000 F, a decided advantage over furnace heating which has an upper limitation of about 2600 F. The brazing machine is controlled from several consoles which control machine movements, purging of air from the envelope and introduction of argon gas for the brazing cycle, and the timing and temperature of the panel being processed.

**Selective Control**

One unique feature of the brazing process is that various sections of a panel can be heated independently of other sections. This is accomplished by installing sensing devices inside the honeycomb panels and connecting the devices to an electronic control panel. As the panel heats up, the sensing devices transmit signals to the control panel, and various combinations of quartz lamps are energized and controlled selectively to provide uniform time and temperature, even when the part has nonuniform density. Brazing cycles on the machine vary from 2 to 15 minutes, depending on the complexity of the panel being brazed. After brazing, the part is moved automatically to a chill form station for fast cooling.

The largest machine Norair has built so far will handle a part which is 2 by 3 feet in size. At the present time they are building another machine with a 3 by 6 foot capacity. One machine, capable of brazing moderate sized panels, has been in operation at Norair for nearly two years. In addition to the stainless steel family of metals, the process has been applied to titanium alloys and is adaptable to the more exotic metals in the columbium and molybdenum groups which are coming into prominent use in the design of satellites and space vehicles.

The U. S. Air Force has expressed interest in the new development by awarding a $956,447 contract to Northrop Corp. to adapt the brazing process to the manufacture of advanced aircraft and space vehicles. The contract is with the Manufacturing Methods Div., Aeronautical Systems Center at Wright-Patterson Air Force Base in Dayton, Ohio. It authorizes seven phases of work covering Nortobraze manufacture of stainless steel honeycomb panels in a variety of shapes, sizes, and thicknesses.



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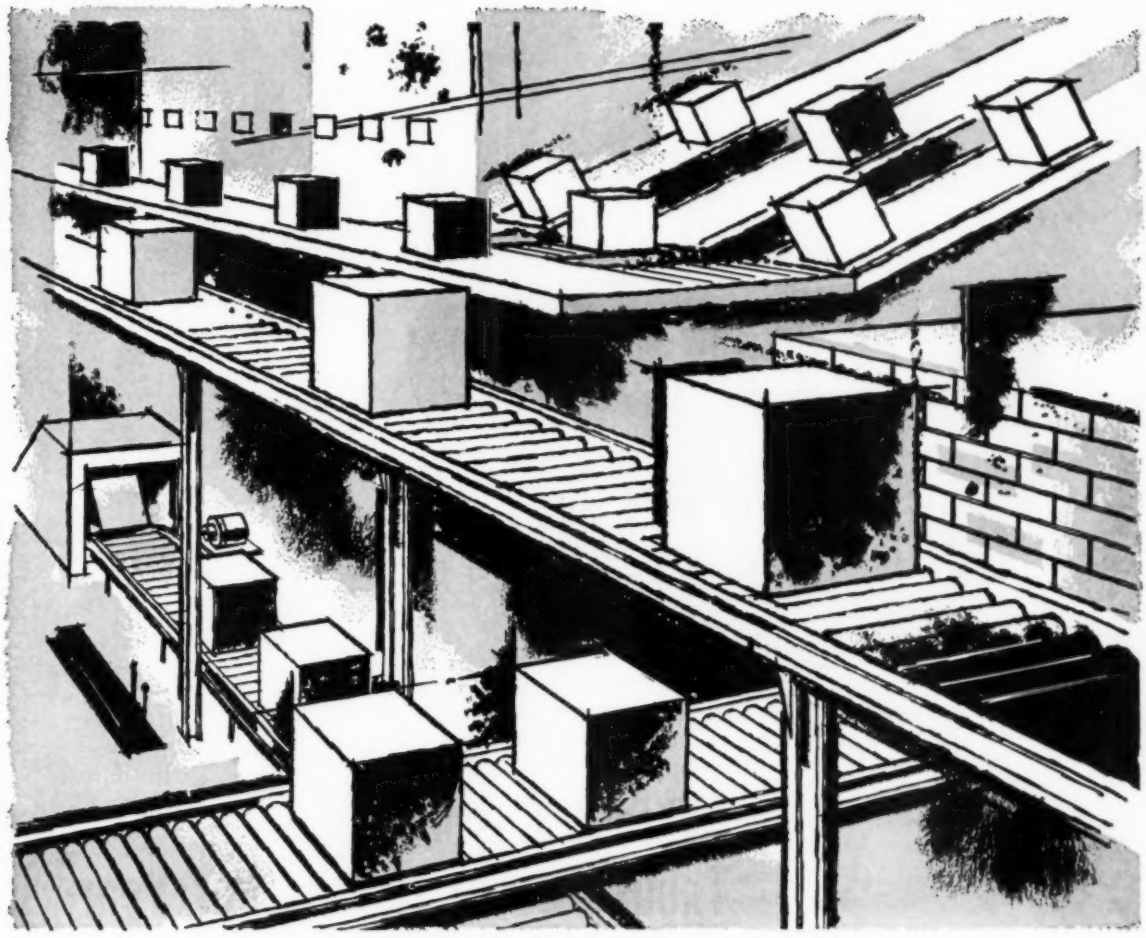
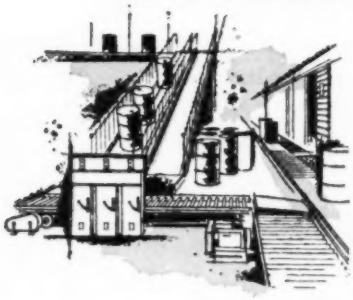


# NO LOST HANDLING TIME HERE



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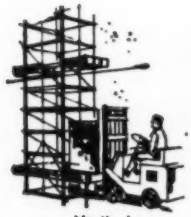
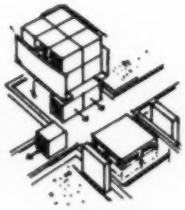
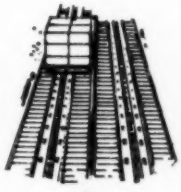


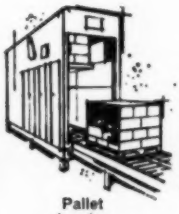
Vertical Lift



De-Palletizer

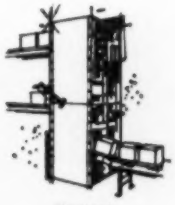


Air Chain



Pallet Loader

Spiral Conveyor



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AUTOMATION

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# Changing Scene

During the decade past the tremendous expansion of business enterprise has been widely noted in such indicators as rising employment and gross national product. Impressive as these indicators are, their real significance in terms of the vast increase and changing character of the manufacturing activity involved is often overlooked.

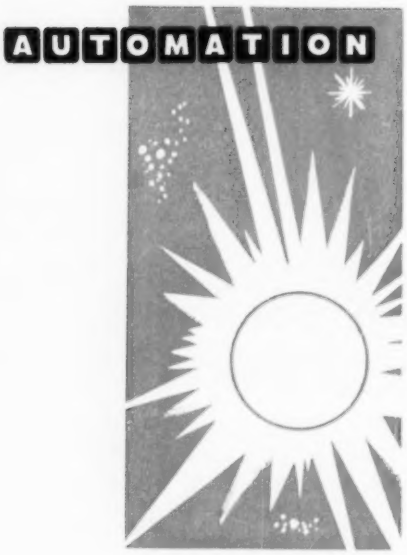
Yearly plant and equipment expenditures have ranged over 30 billions regularly in recent years. This fact alone indicates activity of tremendous scope. Just to fulfill this enormous program makes widespread development imperative. But the most significant factors in this dynamic expansion are the shift of major emphasis from plant to equipment, and the pressing need for integration of this manufacturing equipment on an automated systems basis. Because integrated systems engineering has not been generally available through equipment builders, user manufacturing engineering groups have been created by manufacturers in all industries to handle this responsibility.

Despite this new look automation is bringing in industry, builders of manufacturing equipment still evidence a strong tendency to view their services on a status quo basis—almost in an atmosphere of nostalgia. But the scene is fast changing.

To serve the projected plant and equipment needs during the coming years—greater than any in history—manufacturing equipment builders must take a fresh look at industry's problems. Under the impact of the most dynamic period of manufacturing activity yet to be encountered few past practices will remain intact. Industry will be dominated by a new breed—the manufacturing and processing expert fulfilling a function created by the rising complexity and sophistication of industry.

Demand will grow for equipment builders to accept a greater degree of responsibility for over-all systems designed and engineered specially to realize the benefits from new methods and processes of more integrated, automatic character. Expanding markets, competition, and advancing technology have made the change inevitable.

EDITOR




# A LOOK INTO TOMORROW

**Automation is in the mainstream of present industrial developments. Increased productivity of manufacturing facilities is certain to have marked influence on the future of the country and the individuals who inhabit it. More knowledge of the technological and sociological factors involved appears essential to future well-being.**

By **JOSEPH HARRINGTON, Jr.** Head, Mechanical Engineering Section Engineering Div., Arthur D. Little, Inc., Cambridge, Mass.

MY talk this evening is going to be different from any other you have ever heard on the subject of automation: I am *not* going to attempt to define the word. This is, after all, the Fourth Conference on Manufacturing Automation; if you don't know what automation is by now, there is little I can do to help you.

There is one thing which I think must be apparent to everyone. Automation is just one link in a long, long chain—the modern phase of an infinite continuum called mechanization. It extends backward through many centuries to the dawn of civilization, and it will extend ahead through even more centuries. What has evolved in the past is history, but what will happen tomorrow is as yet unknown. It is, therefore, a safe area in which an after-dinner speaker can roam. It is also very intriguing, so let us take a look into tomorrow.

I sense in the engineering world today an undercurrent of excitement which usually portends some great change. For hundreds of years we have been improving the productivity of our tools. Progress was slow in the days when hand tools were driven by muscle power, but two centuries ago there was a sudden upward surge in the rate of progress when steam and then electric power were added to replace muscle power. Today we have a feeling we are on another point of inflection of this curve of productivity. We sense a forward surge not unlike that which we feel when the engines first drive a plane forward at take-off.

I have asked myself what causes this feeling of change and turmoil. I think that it can be traced to two factors—one technological and one sociological. Both are relatively new, and both are very vital.

First is the recent advent of some powerful new techniques—systems engineering, servomechanisms, and reliable electronic equipment. All three were greatly perfected in the war years, and their impact on the industrial scene was clearly evident by the early 1950's. Self-controlled machines and preprogrammed machines became practicable industrial realities.

Second is the artificially and unnecessarily induced fear in the minds of labor that the new class of machines would make the workman obsolete. They were told that pushbutton machines could and would do all the work, and to many a nonanalytical mind this concept held all the seeds of panic. The newly coined word, automation (whatever it meant), became anathema overnight, as if

This article is based on a paper presented at "Fourth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and Manufacturing Engineering Council, April 1960.

it were a Jack-and-the-Beanstalk giant which had suddenly appeared and was uncontrollable. No wonder we feel that strange forces are astir.

## ▶ Economics of Technology

Actually, there is absolutely no mystery whatever in the technological future. The machines which will be offered to you for sale in 1965 are on the drawing boards now. The new materials and the new processes which will be announced in 1970 are already in the test tubes. All the engineers, research workers, economists, and workmen who will enter the area between 1960 and 1980 have already been born. If there is any mystery in the next decade, it is merely one of industrial secrecy or plain failure to communicate.

We know exactly where we are going, and who will be available to do the work. So let's stop worrying about miracles, at least for the next decade.

The real mysteries are not how we are going to automate—this conference is loaded with details about "how to do it"—but can we get it done, and can we then live with it. These really aren't engineering problems at all. (Probably that's why we are discussing them this evening, instead of during one of the technical sessions.) But we had better understand them, because we will be expected to solve them.

The public seems to reason, "Engineers invented the machines; let them solve the sociological problems they created." This is of course completely illogical, as you can see if we were to transfer the idea from the engineering profession to the medical profession, and require all married men to become obstetricians.

The two basic questions facing us are: 1. How can we form capital fast enough? 2. How can we educate people to live in an automated world? Any predictions for the world of tomorrow require an answer to these questions.

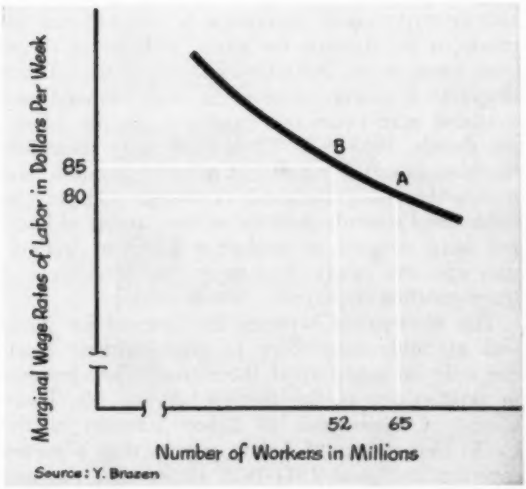



Fig. 1—Relationship of wage rates to employment is expressed graphically by the Clark Diagram.

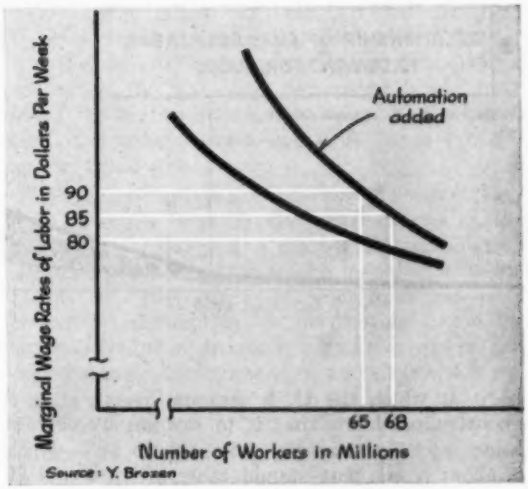


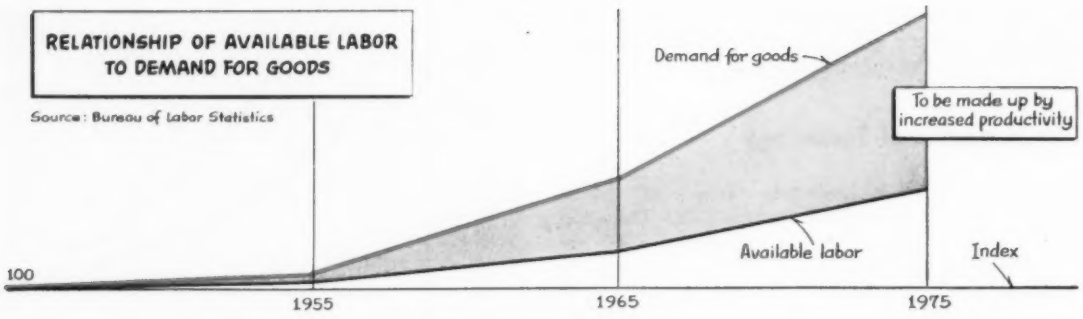

Fig. 2—Clark Diagram of *Fig.* 1 with additional curve portrays the effect of increased automation on the wage rates vs employment relationship.

Let's explore the relationship of automation, productivity, wage rates, employment and capital investment. So much has been written, and so many conflicting opinions have been flatly asserted about automation and our material welfare that it behooves us to understand as clearly as possible what these terms mean and how they are related. I am going to ask you to follow me, if you will, through an elementary exercise in economics, with subtitles in English. Economists use a so-called Clark diagram to illustrate the well known relationship between wage rates and employment.

Assume for the moment that you are a manufacturer in a competitive market and that you have priced your product with as small a markup over the actual cost of labor and materials, as is consistent with a reasonable profit on your investment. Now, if the wage rates are forced up without a corresponding increase in the productivity of the operators, you are faced with the unpleasant alternatives of either operating at an unprofitable level, going out of business, or raising your prices. An increase in price implies a decreased production in accordance with the well known laws of supply and demand; and a smaller production means a smaller total employment in your plant.

If, for example, your original condition of equilibrium is represented by a point such as Point A on this curve, *Fig.* 1; your new position will be represented by Point B, which represents a somewhat higher wage rate and a decreased number of workers. Of course, the converse is true: If you enjoy a decreased labor rate, then you can employ more people.

Senator Douglas has studied the shape of this curve and has determined that the slope at the




point at which the U. S. economy is operating is about minus four. That is to say, an increase in wage rates, for example, from $80 to $85—which is about 6 per cent—would cause more than a 20 per cent decline in employment, all other things being equal.

In plain English, a man can't expect to get paid more if he doesn't produce more. If he insists, he puts his job in jeopardy.

Suppose you have been saddled with an increase in wage rates without a corresponding increase in productivity. How does this affect your thinking about automation? Do rising wage rates act as an incentive to greater automation? Obviously they do. The higher wage rates merely introduce a new factor in the old evaluation of the justification for mechanization.

When you are weighing the wisdom of installing a new line of machines, one of the contributory factors is the labor hours which will be saved by the new method or equipment. Now, if the price of labor per hour has increased, then the savings which will be accomplished by the proposed mechanization will similarly increase. Rising wage rates, therefore do stimulate automation, all other factors being equal.

Now what does this do to our Clark diagram? Professor Brozen of the University of Chicago has demonstrated that with the availability of increasing mechanization, the new curve is in a higher position on the diagram, Fig. 2. The reasoning is that if the cost per unit for machinery goes down, then the cost per unit for labor can go up without increasing the total cost. You are still profitably and competitively in business.

This has been shown diagrammatically by the addition of another curve to our first diagram. As an example, it shows that where $80 wages corresponded to 65 million persons employed, $90 marginal wage rates can with automation be sustained with the same labor force.

What actually happens is that there is some increase in wages and some increase in the working force, and conditions will probably stabilize at some new point such as in this example, an $85 marginal wage rate and a total labor force of 68 million. (These figures are illustrative, of course. They are not predictions of coming employment levels.) Thus, expansion of output and of employment both follow the increasing availability of more productive equipment.

We have, therefore, demonstrated the interrelationship between automation, wage rates, and employment.

## ▶ Employment Outlook

A rise in machine productivity (automation) *prevents* unemployment; it *does not cause* it. To put it another way, if machine productivity had not increased over the past decade, unemployment would be greater now than it is. In plain English, a spiraling wage rate and a fixed output sucks in automation like a spiraling tornado sucks up shingles. We should not, therefore, fear automation, but accept it as a natural partner of the inevitably spiraling wage rates. Our real problem is to determine whether we can keep these two factors in balance.

In the past decade, both factors have been active: The employment-destroying effect of the tremendous increase in real wages and the employment-creating effect of automation. The former has been the dominant factor, and if it were not for the automation of the past decade, the nation would be in really bad shape today.

In 1955, the Bureau of Labor Statistics made a long-range prediction that in the decade 1955-1965 this country would experience a 50 per cent increase in the demand for goods, with but a 15 per cent increase in available man-hours to fill this demand. A similar increase in both demand and available man-hours was predicted for the following decade, 1965-1975. These predictions reflect, on the one hand, a rapidly growing population and a steadily rising standard of living, and on the other hand a steady decrease in the number of hours per week devoted to productive labor by individuals and the steady decrease in the proportion of the population employed.

The discrepancy between the demand for goods and available man-hours to produce these goods can only be made up if there is a steady increase in productivity of the average worker. Mr. Ewan Clague, Commissioner of Labor Statistics of the U. S. Department of Labor, reports that a survey covering the years 1947-1956 shows that the real product per man-hour increased at the rate of from 3.4 to 3.9 per cent a year, depending on the par-

ticular concept used in measurement. It would seem that this rate, if continued, would just about permit us to keep up with the predicted demand.[1]

It seems anomalous that in an era of rapidly expanding population we have a decreasing number of productive man-hours per capita, but this is indeed a fact. If we are going to hold to our present increasing standard of living, we shall have to automate to the limit of our ability.

## ▶ Capital Requirement

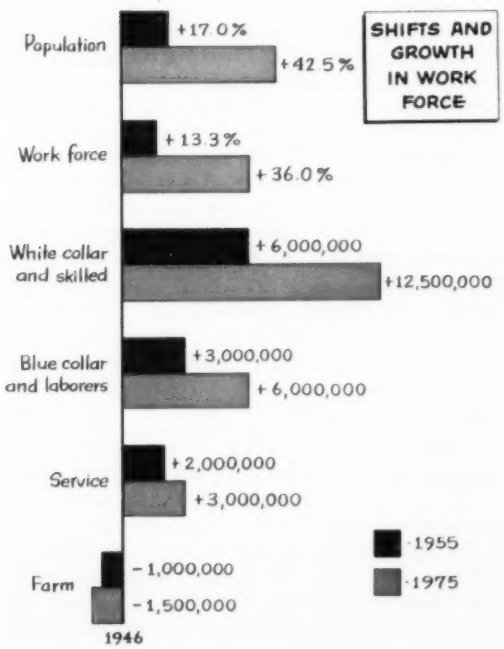
Our capacity to automate is a direct function of our ability to form capital. This can't be done overnight. It costs a lot of money to automate and it takes a lot of time.

In 1950, Professor Norbert Wiener, of M.I.T., wrote his famous prediction that factories would be fully automated in 10 years, or so the public—particularly the labor unions—understood him to say. It is now 1960: In all fairness we should note that the second edition of the book, "The Human Use of Human Beings," published in 1956, says: "Short of . . . another great war, I should give a rough estimate that it will take the new tools ten to twenty years *to come into their own.*"[2]

Professor Brozen has estimated that the investment necessary to automate the manufacturing industry alone would run on the order of one half a trillion dollars. Remember that $8 billion was spent in 1958 for capital formation over and above that necessary for replacement and keeping up with the population growth. Dividing one-half trillion dollars by $8 billion per year, we find that over 60 years would be required to raise all of manufacturing industry just up to the level of today's technology. By that time, technology would have moved far beyond where it is today. Also, bear in mind that today's technology is far from the 100 per cent pushbutton stage.

1. Clague points out that the impact of automation on productivity cannot be isolated quantitatively; there are too many factors affecting it.

2. Italics added.




This calculation pretty effectively answers Professor Wiener's fears. It also gives us one of the answers to our question of the possible pace of, and limitation on, automation in the manufacturing industries. It seems safe to say that there will be a tremendous demand in the foreseeable future for capital investment in more productive equipment. We have more know-how than we can put to work. There just isn't enough money to go around, and it does take capital to put know-how to work.

There are a number of things which limit automation—lack of engineers, lack of energy or materials, lack of understanding on the part of management (which means lack of confidence), but above all lack of capital. We can't save enough money in this country to carry out all the things we know how to do. In fact it looks as if we would have barely enough capital to keep our expanding population on an improving standard of living.

Our dilemma is that we want to have our cake and eat it too. We want full employment, but we want higher wages. We want our standard of living to increase, but we don't want to work for it; we want more leisure time and to spend our money on entertainment instead of putting it into savings, i.e., capital formation. Now if you really feel the need to worry about something, worry about that dilemma. It's worthy of your mettle.

What to do about it is a little out of my line. I'm sure if there were any obvious or easy answers, they would have been prescribed long ago. I suspect that unorthodox and possibly heroic measures will have to be taken to achieve a breakthrough, but achieve it we must. That is our first major task for tomorrow.

## ▶ Education Necessary

Now for our second basic question. How can we educate people to live in an automated world? We have been talking heretofore about wage rates, capital investments, and employment from the point of view of industry as a whole. Let's swing around now and talk about them from the individual's point of view. When automation comes, what happens to the workman's paycheck? What are his chances of losing his job? What will the new equipment require of him?

It can be shown that for every $1000 invested in capital equipment here in the United States, $350 is added to the national income. No one person, of course, gets all of this. Twenty dollars of it goes for local real-estate taxes, $50 of it goes to the Federal Government in corporate income taxes, $60 of it is interest or dividends and goes to those who saved up and invested the original $1000 of

capital, and the remainder, $220, goes to labor as increased wages. Clearly, it is to the benefit of labor as a whole to foster capital formation and investment in more productive machinery.

The truth of this can be demonstrated if you will stop to think of those industries which have made the greatest progress in automation in the last quarter of a century. Think of them, if you will—steel, automobiles, chemicals—and you will realize that each of them is outstanding for a high wage level.

Over and over again, we hear of cases in which a mechanization program has so stimulated the activities of a company that employment by the company has actually increased rather than decreased. There are, of course, some changes in job assignments in any such evolution, but these are resisted chiefly by those people too lazy to rise to the challenge of anything new even in progress in their own financial and organizational status.

There is a great deal of scare propaganda going around about technological unemployment. Actually, there is no such thing as technological unemployment. There may be technological displacement, but seldom do we pay much attention to the absorption of workers which occurs because of technological change. If there were technological unemployment, we would expect to see the greatest drop in employment in those areas having had the greatest investment of capital in more productive equipment. Similarly, we would expect areas which have enjoyed scant mechanization to show the greatest stability of employment, but quite the contrary is true. For instance, the steel, automobile, telephone, and chemical industries have invested tremendous amounts of money in automation, and in every one of them we find that employment is vigorously increasing.

Just for the record, note too that more automatic machinery requires less physical effort, stamina, and endurance to operate. It calls for more judgment, experience, and stability. Thus, the older worker has a better chance of retaining his economic usefulness than he does without the advent of automation.

What about the absorption of workers which occurs because of technological change? There is a strange and alarming equation apparent in the development of automatic machinery. If you can justify the introduction of a new machine, you expect that the savings in labor, material, and other production costs will be equated to the costs of developing and building the new machine. While the expected savings come only partly from labor at the machine operator level, the development and construction of the automatic machinery is largely labor and draws upon highly skilled machinists, electronic technicians, and engineers. On a dollar-for-dollar basis over the two-to-five-year payback period, we are absorbing scarce and expensive man-hours of skilled labor when we displace an equivalent value of semiskilled labor. The scarcity of this skilled labor is one of the limiting factors on the pace of automation to which I referred a little while ago.

The record of the last decade shows clearly this transfer in the manufacturing industries from production workers to nonproduction workers, particularly scientists, engineers, and highly trained people of all sorts. At the turn of the century, 7 per cent of the total work force was in the nonproduction category; today, the percentage is 24 per cent. There will be a high premium in the future on educating, retraining, and upgrading workers. A trend has already set in but it must continue and even accelerate. I anticipate a lively demand in the next decade for skilled machinists, machine erectors, electronic maintenance men, instrument technicians, and computer operators, as well as for engineers, designers, and inventors.

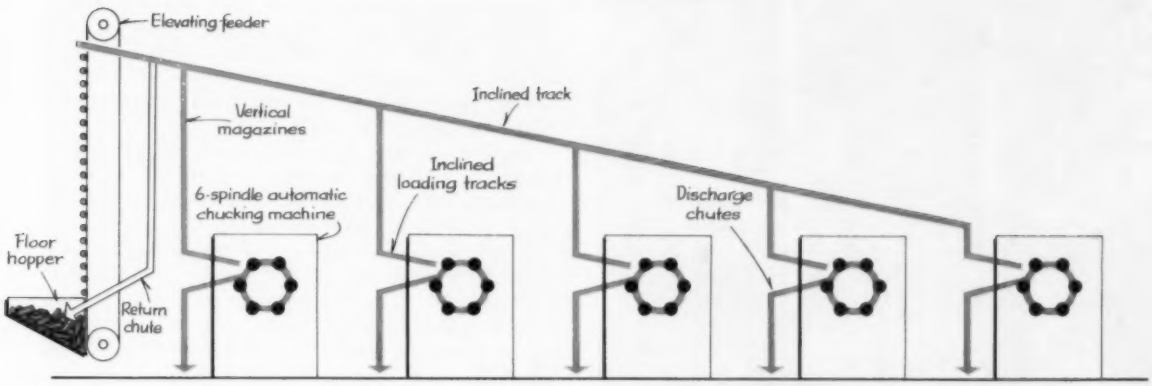
In the long term, then, automation is going to put a tremendous burden on the educational talents of the country, for engineers, economists, technologists, technicians, and maintenance men are going to have to be trained to conceive, design, build, and service automatic machines. This burden must be carried by both the public schools, the colleges, and the universities on the one hand, and by industry itself on the other. Even organized labor is taking a part in upgrading and retraining its members. Where essential, industry and labor can retrain those members of today's work force, but the thing to worry about is how to give the right training to the next generation as it is growing up.

Apparently a key problem is the creation of interest in scientific and engineering training amongst the high-school students of today. In spite of the current efforts to interest young people in scientific or technical careers, we are not getting a corresponding upsurge of entering students. In the post-Sputnik clamor for engineering training in our schools, the leading educators in this country spoke up firmly against the abandonment of fundamental training in the liberal arts. And they were quite correct in doing so. What it comes down to is that we need to get both the liberal arts and the engineering training if we are to remain abreast of progress. And this means more and harder work for the young people.

Previous generations of young people in this country, and young people in other parts of the world today, have thrived on a far heavier work load than our youth seem inclined to carry. If I may be permitted, I would point my finger at this as one of the key problems of the day.

We must exert every effort to train young men and women in science, engineering, and technology to meet the technical demands of a mechanized civilization; and we must also exert every effort to train them in liberal arts to meet the problems of personal and civil life in this increasingly complex world.

And that is our second major task for tomorrow.




1 Handling system for piston pins in an automotive plant eliminates manual loading of pins in automatic chucking machines. Pins are delivered to floor hopper from previous machining operations by fork truck. Elevating feeder lifts pins to inclined track where units are oriented and fed to vertical magazines servicing chucking machines.

AUTOMATION TODAY

# PARTS HANDLING SYSTEM ELIMINATES MANUAL LOADING

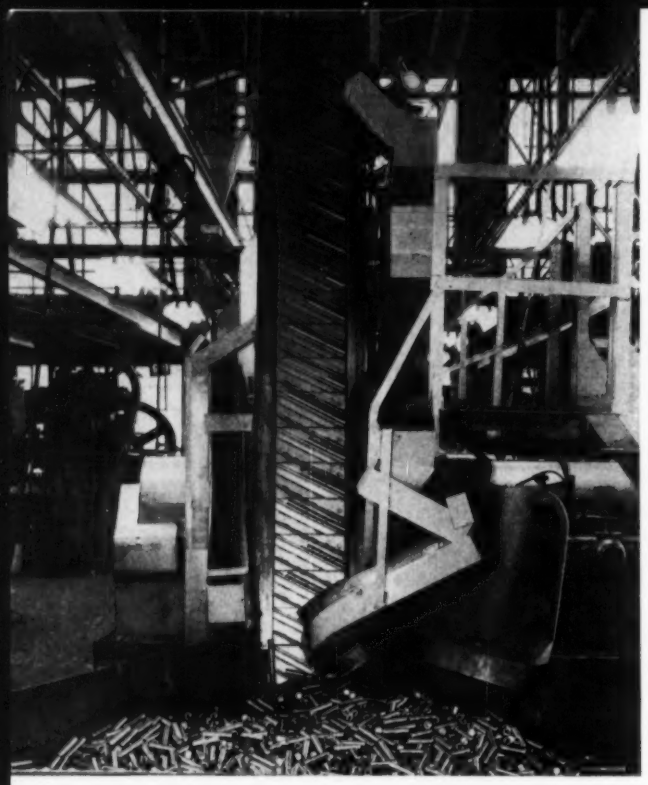
WHEN parts are produced in large quantities, the manufacturing engineer is tempted to continually scrutinize each element of the production process in an attempt to devise and justify additional automated manufacturing techniques. Primary target is usually the work performing equipment but, in many cases, this equipment is well adapted to the process, and it is not possible to make cost reduction changes without revamping the process. In such cases, the handling of parts to and from the work performing equipment offers a profitable target for improving production operations.

A case in point is the production of piston pins in the Flint, Mich., plant of Buick Motor Div., General Motors Corp. These parts are machined from bar stock in large quantities prior to heat treating and hardening. First operations are performed on bar automatics which automatically drill a $\frac{5}{8}$-inch hole through half a pin length in three drilling stages, ream the hole, chamfer the end of the hole and the outside diameter of the bar, and, in a final operation, cut the pin to length and chamfer the outside diameter of the cutoff end.

The pins are then transferred to a battery of five 6-spindle automatic chucking machines, built by Cone Automatic Machine Co. Inc., which complete the drilling of the $\frac{5}{8}$-inch hole in three stages, finish ream the hole, and chamfer the hole end. Originally, these machines were manually loaded since each partially machined pin had to be oriented when it was placed in the spindle collets. Once loaded, the pins were automatically cycled through the machining stations and were ejected from the spindles upon completion. However, an operator was required at each machine to load pins into the collets.

Since the machines were considered satisfactory for the job being done, it was decided to upgrade the production process by installing a system to automatically load the piston pins into the collets. Several methods were investigated for feeding parts into the machine and for distributing parts from a central source. After study, the distributing and loading system shown in the accompanying illustrations was built and installed.

Piston pins are transported from the bar automatics in tote tubs by a fork truck. This truck is equipped with a swivel support to permit dumping of the tubs into the floor hopper adjacent to the chucking machines. Since the oily coolant used on the



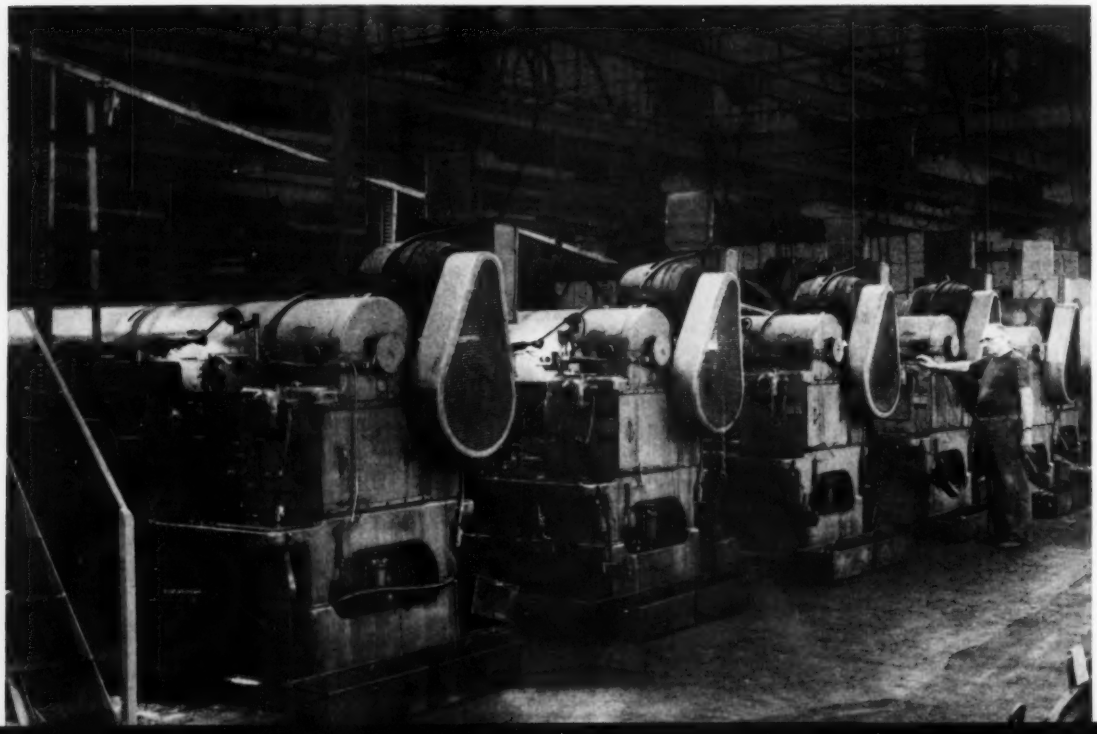
2 End view of system shows floor hopper and elevating feeder. Cleats on the feeder belt pick up one to three pins per cleat and lift them to an orienting device at the head end of the inclined distributing track. Improperly oriented pins drop back to the floor hopper by means of the series of chutes on the right side of the conveyor.

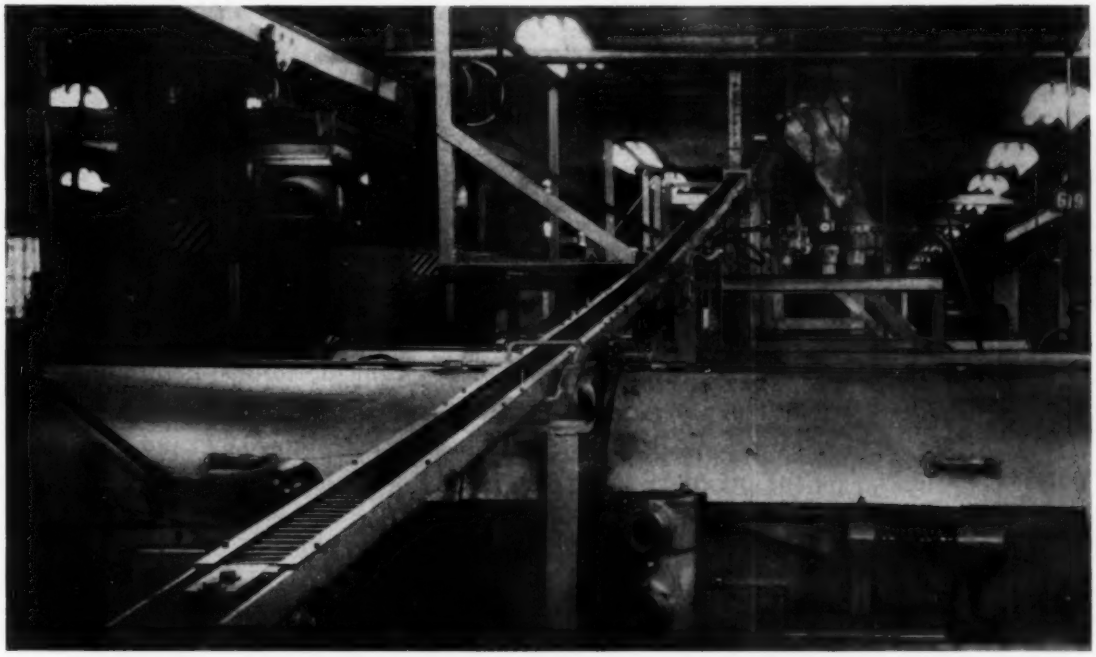
bar machines adheres to the pins and is likely to create sticking at some points in the chucker feeding system, the pins are washed in kerosene before being fed into the tote tubs. This procedure also prevents rusting of the pins in the event that the parts are stored for a period of time.

The floor hopper has an inclined bottom, and its sides narrow at the discharge end. At this point an elevating feeder having diagonal cleats moves vertically past the pile of pins and picks up one to three pins per cleat. Near the top of the feeder, the pins slide off the cleats and are fed onto a separator plate where one end of each pin projects over a knife edge. At this point each pin has a light end in which the $\frac{5}{8}$-inch hole has been drilled and a heavy end which has not been machined. When the heavy end projects across the knife edge, the pin tilts and drops into an inclined track running over the chucking machines. When the light end of the pin projects over the knife edge, the pin does not tilt into the inclined track but rolls into a series of chutes which carry it back to the floor hopper. If the inclined track is filled, the pins are also directed back to the floor hopper by means of the chutes.

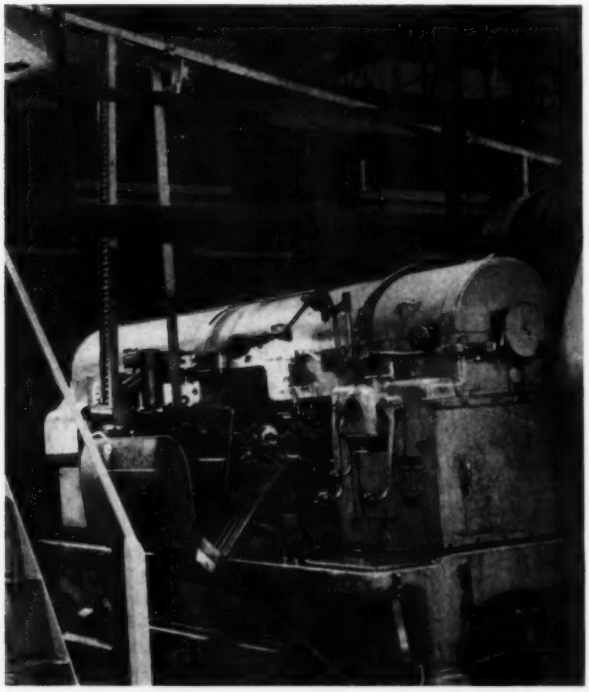
As the pins roll down the inclined track, they are guided past five openings in the bottom of the track which allow access to a vertical magazine ahead of each chucking machine. If a particular vertical magazine is filled, the pins roll past the opening to the next magazine. However, as a pin is loaded into a chucker, all pins in the magazine move down one pin diameter, allowing another pin to drop into the vertical magazine.

3 This general view of the chucking machine battery shows the inclined distributing track slanting downward from the upper left to right. Immediately in front of the track is a steel platform for servicing the handling system. Air operated vibratory devices mounted under the inclined track keep pins from jamming.





4 Slope of the inclined distributing track from the elevating feeder in the background to the fifth chucking machine in the foreground is shown in this view. At each machine position, an opening in the bottom of the inclined track allows pins to drop into vertical magazines.



5 Closeup view of one chucking machine gives a clear view of the handling system. Sloping across the top of the picture is the inclined track. Piston pins drop from this track into the vertical magazine and feed into the short inclined loading track leading into the machine. The pin is pushed into the spindle collet by a horizontal loading ram. After machining is completed, the pin is ejected from the collet and slides down the discharge chute to tote box.

Each vertical magazine bottoms into a short inclined loading track in which the piston pins collect against a stop. This stop aligns each pin so that it can be pushed into an open collet by a loading ram when the collet is indexed into position. As the loading ram retracts, the next pin rolls into the loading position and is ready to be inserted into the next empty collet. During machining, the collet and pin are rotated and indexed to the various operating stations. At the completion of the cycle, the collet opens, and the finished piston pin is ejected into a discharge chute.

Some difficulties were encountered with the handling system when first installed. Pins would occasionally cock or stick in the inclined track and jam the feed. This trouble was overcome by applying air operated vibrators at several points along the track.

With the new handling system, one man can tend the five machines. A helper takes care of the handling system, keeps the floor hopper filled, and removes finished pins from the chucking machines.

# CONTRACTING FOR CONTROL DEVELOPMENT

**Development of a custom control installation requires a working agreement between buyer and builder. Considerations upon which a satisfactory agreement can be founded are discussed by the author. Emphasized is a flexible step-by-step approach and other practical points from experience with such development.**

By **ROBERT B. STERNS,** Director of Engineering, Sterns Control Corp., Great Neck, N. Y.

IF A BUYER wants a control builder to develop an electronic control system how can the two parties reach an agreement for such a development? Obviously, a handbook of pat rules to follow number by number is neither available nor likely to appear. Experience in developing control systems, however, suggests consideration of certain general points as a basis for satisfactory buyer-builder agreements.

## Flexibility, Step by Step

When a builder and buyer sit down to work out a contract for development of an electronic control system, the best advice for both may be a warning: Beware of iron-clad agreements.

A lot of builder-buyer misunderstanding stems from failure to realize that writing realistic specifications for a new electronic control system *in advance* is virtually impossible. Developing such a system is essentially experimental, even when the machine or process to be controlled is an old and familiar one. The basic information needed for a successful solution usually comes only after careful study and research.

Therefore, developing a control system with limited or special application can be too great a gamble for the builder to attempt unless the buyer underwrites much of the expense.

A builder with wide experience can keep the buyer's expense down. For example, even if there is no known solution to the control problem, the builder, through work done on other systems, may already possess knowledge and know-how that can be applied to advantage.

In any event, a certain amount of research and development to define the problem and determine control feasibility will be required. Since a research and development job has no value unless translated into a working control, designing a system involves unavoidable financial risk. One way to minimize this risk is to draw up a contract that covers one step at a time.

An actual case history serves as an example to illustrate why a flexible, step-by-step agreement is advisable.

A manufacturer of multicolor sheet-fed printing presses wanted to increase press speed beyond the 100-sheet-per-minute rate for which the press was originally designed. He saw no reason why this could not be accomplished with only minor design changes. Moreover, since previous models had not required automatic controls, the manufacturer assumed that the new, faster model could operate without them, too.

But the new model, once in operation, proved unsatisfactory because of faulty registration. Faced with loss of a heavy investment, the press manufacturer called in a control system builder to see if automatic registration controls could solve the problem.

The builder's first question was: "What is the accuracy of the press at high and low speeds when registration is properly maintained?" In short, the builder first had to know the inherent accuracy of the press as a point of departure in developing any control system. But the press manufacturer could not answer the question.

This posed a problem for the control builder. Since the machine was being redesigned and operating conditions from the control standpoint were unknown, the risk in attempting to design a satisfactory control without sufficient data was excessive.

Static measurements on the press could not give the needed answers. Nor could any amount of previous experience with other presses provide the data the builder needed

for this one. Dynamic measurements were required to tell why the press maintained register at low speeds but not at high speeds. Therefore, a data analyzer with controller functions had to be built in order to study the operation of the press.

With the data supplied by dynamic measurement, the control builder would then be able to build a prototype control system that, although it might have to be modified later, would not have to be redesigned. At the same time, data obtained by dynamic measurement would enable the builder to tell the press manufacturer what improvements would have to be made on the press.

The press manufacturer agreed to the need for a study of the problem, with a final solution to be based on whatever data emerged from the initial study. The builder and buyer then agreed to draw up a contract. In keeping with the builder's policy of minimizing risk through a step-by-step approach, the contract covered only the first phase or data acquisition and proposal phase. Since the unknown can hardly be stipulated in a contract, it was obvious that the agreement would have to be kept quite flexible. But both parties realized that some figure would have to be stated as the cost of the first phase in view of budgetary considerations and the buyer's need to sell this expenditure to higher authority.

Using his past experience in working up prototypes as a guide, the builder was able to quote a figure to cover the cost of the first phase, and the project was underway. At the end of the first phase the two parties were able to agree on the remainder of the contract. The project was brought to a successful conclusion with development of an installed and working control system that met all the buyer's requirements because it was based not on guesswork but on fact.

## Prices in a Range

Anyone familiar with development work knows that the final cost of a project rarely coincides with original estimates. In fact, it may be no exaggeration to say that if final costs were known in the beginning, many development projects would never get off the ground.

With this in mind, our company, for one, follows the policy of quoting to its customers not a final price but a price range. Our experience has been that contracts work out best when a minimum and maximum cost are understood, with plenty of leeway for adjustments as the project develops. The minimum cost should be enough to cover expenditures needed to prove whether or not the project can succeed. The maximum cost would be the very most the buyer will have to pay to provide for all the inevitable contingencies that arise before a project's successful completion.

The range-quotation policy offers these advantages over single, final price quotations:

1. If the contract terminates by mutual consent at the close of the first phase, the cost to the buyer is kept to a minimum consistent with proving either that the project cannot succeed or that, although feasible, it would be too costly.

2. The builder has at least been reimbursed for time and material expended and is not required to quote a high price to protect himself against all possible contingencies.

3. If the final cost of a successful system is less than the maximum quoted, then the buyer has saved money. Our company finds that the average contract it completes runs about 25 per cent below the maximum cost quoted.

These, then, are some of the advantages of flexible agreements that spare both sides the necessity of meeting specific terms that may prove unrealistic because they were drawn up before the problem was clarified. Now, what are some of the ways that buyer and builder can keep their agreements flexible throughout each phase of a development project?

## Keep Objective in Mind

First of all, consider the first phase. In working out this initial phase of an agreement it is well to keep the objective of the project clearly in mind. By objective is meant precisely what the buyer expects the control system to do, not vague goals such as "cut labor costs" or "increase efficiency." True, general benefits such as these may result from installation of a control system, but the important thing to remember is that a control system is designed for a precise function, not as a means of realizing a general approach to production problems.

Again, an actual case history can be cited to illustrate the advantages of keeping the objective in mind, besides keeping an agreement flexible so that any deviation from the planned approach can be met and corrected in good faith.

A container manufacturer decided to give his customers a better product, with only a slight increase in price. Producing the new, improved container required redesign of 75 per cent of his existing machinery. Moreover, the relatively simple controls used before were inadequate for the new, more complex operation. It was understood from the beginning that the objective in developing a control system was to maintain for the new operation both the rate and quality of production and the reject limit that existed before.

The control system had to be designed and built while the machinery itself was being redesigned, so that no time would be lost in getting the new container into production. Through an oversight, the container manufacturer made certain modifications in design on the machinery without realizing their importance to the control system builder. When this was discovered by the control builder, he knew that the objective could not be met without modifying the control system to allow for the changes made in the machinery.

These modifications of the control system took extra time and money, but there was no misunderstanding between the two parties. The objective of the project had been clearly outlined and agreed to, and it was understood that each side was responsible for keeping the other fully informed of anything that might hinder realization of the objective. The agreement had been kept sufficiently flexible to allow for an adjustment such as this.

The end results of the project went beyond the stipulated objective. Once the control system was in operation, the speed of the machinery was actually 20 per cent greater

than before, while the reject rate was cut in half. At the same time, the quality of the product was higher because the electronic registration controls made possible a better-looking container that found greater customer acceptance.

It is well to remember that developing a control system can have pleasant as well as unpleasant surprises. Although a proposed solution may not always work, often it is found that the control brings benefits not even contemplated in the agreement.

## Firm Understanding on Costs

If keeping the objective in mind is all-important in the first phase, in the second, or development phase, the emphasis shifts to firm understanding on costs. Although a firm quotation usually can and should be given for the first phase, the nature of the development phase requires more flexibility. One thing to keep in mind is that any worthwhile development is going to cost a certain amount of money, and trying to pare expenses too closely may result in total waste.

Moreover, in the development phase there arises for the first time the possibility of financial benefits that might extend beyond the immediate project. Naturally, if the project is a one-shot proposition applicable solely to a specific operation, then the control system builder is concerned only with a fair profit from his work for the customer. But sometimes the second phase of a project results in unique developments that may have a long-range money-making potential. To provide for this possibility, an agreement should include provisions for sharing profits from any widely applicable development.

In general, we have found that fair and workable agreements can be made to cover other, long-range applications of the development work if five provisions are included in the contract:

1. The control system builder agrees that he will not reveal to anyone else anything he has learned about the production techniques of his customer.

2. For a period of time, defined in the contract, the builder will not do similar development work for any of the buyer's competitors.

3. The builder is free to use certain techniques worked out in the project for other companies that are noncompetitive with the buyer's company.

4. When the buyer of the system desires to restrict its use by competitors and wishes to take out patents for that purpose, the control system builder will assist the buyer in obtaining the patent, but the builder will reserve the right to use the patent without royalty payment in any noncompetitive application.

5. Where developments occur that are so unique that the patent holder is in a position to make large profits, then the builder and buyer should agree to hold the patent jointly, sharing all royalties equally. An alternate solution would be for the control system buyer to hold the patent but to permit the builder to have exclusive use of the patents by paying a reasonable royalty.

The patent problem has been discussed here because it can arise and must be provided for in any realistic contract, but the control system builder and the buyer are interested primarily in solving problems and not in making money from patents.

## Co-operation

In the third phase of a contract, what might be called the final or system-building phase, there is another shift in emphasis. Here co-operation is all important. This is the most critical phase of all, because here informal specifications and loose agreements give way to the reality of building a system that must work properly in an actual industrial operation. It is in this phase, too, that it often becomes apparent to the buyer that the builder must be able to produce and service the final system in addition to performing research and development work. In fact, the builder's ability to see the project through to the end is an important consideration in selecting a builder.

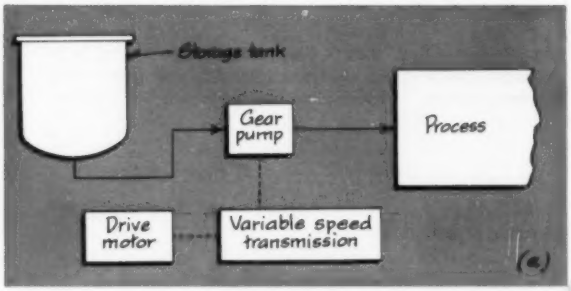
No agreement covering the final phase should be arrived at without a joint buyer-builder conference that results in firm understanding. At this point it must be decided whether or not the provisional budget figure previously accepted is still applicable to the specifications that have now been established. Misunderstandings during this crucial period can best be avoided by close liaison. Failure of the builder and buyer to keep each other informed at all times can lead to serious trouble.

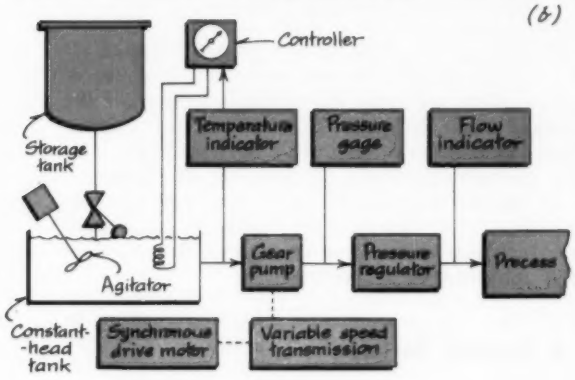
For example, a control system builder was well along in development of a sheet-length measurement device for a shear when he discovered that he had not been adequately informed of other problems related to the solution of the control problem. He had understood from his customer that the only accuracy problem in cutting sheets on the shear line involved proper control of the feed mechanism. In the mind of the customer, the shear length problem was entirely separate from a gaging problem connected with presentation of the sheets into the shear line.

But this was inaccurate. In fact, the shear length problem and the gaging problem were so closely related as to make solution of one impossible without solution of the other.

Although he was well along in the project, the control builder had no choice but to offer to stop the project since his control, which made no allowance for the hidden gaging problem, now might not work. When this was explained frankly to the buyer, the customer agreed to halting work on the control until the gaging problem could be solved. Work was halted for six months, during which time the buyer licked the gaging problem. Then development of the control system continued and was successfully completed.

There are many other considerations also involved in working out successful agreements. Since the development of custom control systems involves many special considerations for each particular project, an outline of hard and fast rules is not practical. However, the working out of an agreement can be easier if the recommendations presented here are kept in mind.



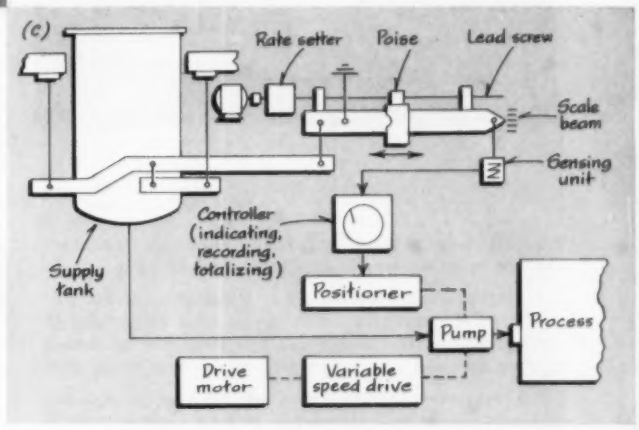




Fig. 1—Diagrams illustrate three systems for feeding liquid at controlled rates from a storage tank to a process. In *(a)* is shown the simplest arrangement. Addition of instruments and controls as in *(b)* provides greater accuracy and safety of operations. System shown in *(c)* employs a beam batch scale, or loss-in-weight type gravimetric controller, to regulate flow of liquid by weight. With this system, need for elaborate temperature, pressure, and other compensation is avoided.

# DISPENSING PROBLEM MATERIALS IN PROCESS

**Anything from granules to explosive slurries can be fed accurately into continuous processes today. Here basic handling techniques for feeding are outlined for practical application.**

By **L. E. HARPER,** President, Omega Machine Co., Div., B-I-F Industries Inc., Providence, R. I.

THERE ARE but a few basic principles that need govern an approach to feeding problem materials successfully. By successfully is meant accurately, dependably, and continuously. An effective way of learning these principles is to review the characteristics that make materials difficult to handle, and to survey current progress in handling several such materials. An additional advantage of such a study is that some of the specialized equipment that has been developed to handle problem materials can be described concurrently.

It is an objective of this presentation, therefore, to discuss handling fundamentals in light of their present-day applications to problem materials encountered in a variety of industrial fields. Information of this type might well assist others in solving their own special material handling problems.

This article is based on a paper presented at "Fourth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and Manufacturing Engineering Council, April 1960.

## Nature of Problem Materials

Physical characteristics of many materials cause them to be difficult to handle. Major characteristics that affect the ease of handling of solids are:

1. **Compressibility.** All materials are compressible to some extent. For example, common table salt may be compressed 15 to 20 per cent by vibration and/or pressure. Carbon or

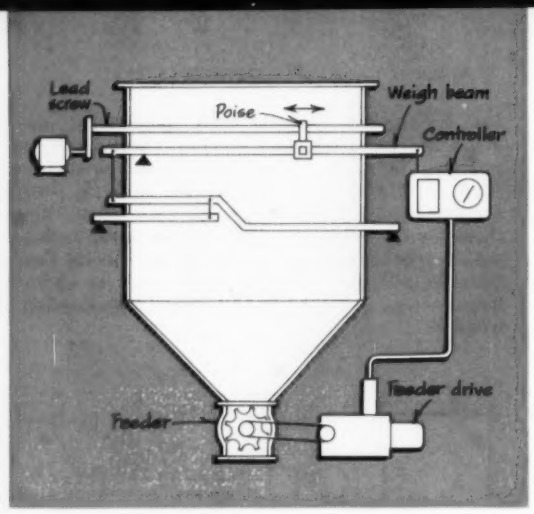



Fig. 2—Simplified sketch illustrates major elements of a beam batch scale, or loss-in-weight type gravimetric feeding system. Either solids or liquids can be handled.

filter aids may be compressed 30 to 55 per cent, and nitrocellulose may be compressed 200 per cent or more.

2. **Nonuniformity.** Materials may segregate in storage bins so that they come to a feeder in the form of particles of uniform size or as well-dispersed mixtures. The percentage of voids may vary from a few per cent to about 30 per cent.

3. **Cohesiveness.** This is a term that describes the tendency of like molecules of a material to be held together so as to resist disintegration. Examples of cohesive materials are wet filter cake, ores, wood chips, and diatomaceous earth which has an angle of repose greater than 90 degrees.

4. **Hazard.** This characteristic embraces materials ranging from noxious to toxic and explosive.

5. **Floodability.** Materials that can entrain air and flow like water in one condition can also arch and pack in hoppers when they are compacted.

In the handling of liquids, attention should be given the following characteristics:

1. **Foamability.** Sometimes called flashing, this characteristic can cause wide variations in liquid density.

2. **Viscosity.** Liquids that have very high viscosities, or have changeable viscosities under different handling conditions, may present flow control problems.

3. **Composition.** Slurries in particular can cause flow control problems because the solids tend to settle out in valves or fittings. In many cases slurries cannot be pumped with metering or gear pumps.

4. **Hazard.** As with solids, liquids may be noxious, toxic, or explosive and require special care.

Many materials have more than one of these characteristics to challenge the process engineer. It is folly to expect uniform, accurate feed rates of compressible materials, by weight, with any of the feeding mechanisms that will be described, because they are volumetric measuring devices. Such feeding mechanisms simply do the work of volumetrically transferring material from a storage vessel to a process. Control means are needed to compensate for changes in material characteristics such as density, cohesiveness, and viscosity.

## External Factors

In many cases handling difficulties are due to the environment, that is, to the process itself rather than material being handled. To illustrate, consider the relatively simple problem of feeding a somewhat viscous liquid from a storage tank to a process. For both transporting and feeding this liquid, a positive displacement gear pump, driven by a motor through a variable speed transmission, will be selected, *Fig.* 1*a*.

This system gets under way with no apparent trouble. However, after a few days, when the more complicated equipment has been debugged, the process engineer isn't quite satisfied with the proportioning, so he looks at the system. He recalls that there seems to be fluctuating pressure in the process that puts a variable back pressure against the pump. To check this, he breaks a union, puts a "T" in the line between the pump and the process, and inserts a pressure gage, *Fig.* 1*b*. He notes a widely fluc-

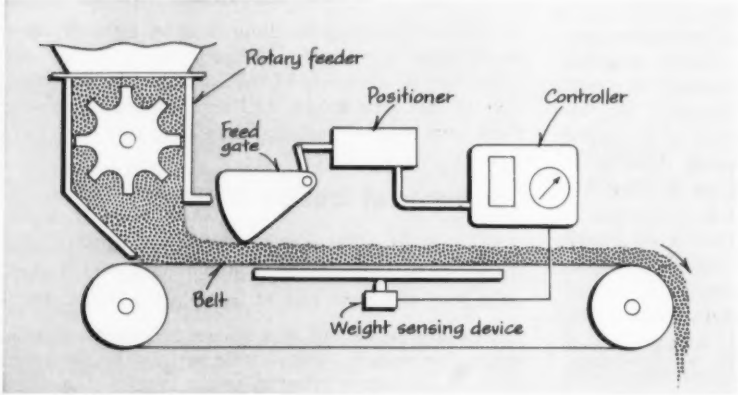



Fig. 3—Continuous belt scale, or stream weighing controller, feeds solids at controlled rates by weight. Rotary feeder handles floodable materials, and feed gate operates well on free-flowing materials.

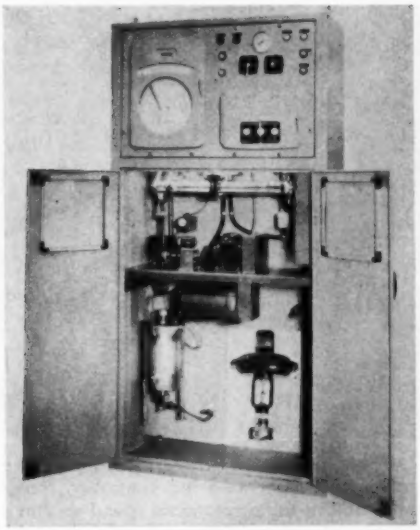


**Fig. 4—Loss-in-weight type controller for feeding chewing gum flavoring to process includes supply tank, lower left, suspended from beam scale mechanism. Air pressure of 5 psi is maintained in tank to facilitate flow of liquid through a valve.**

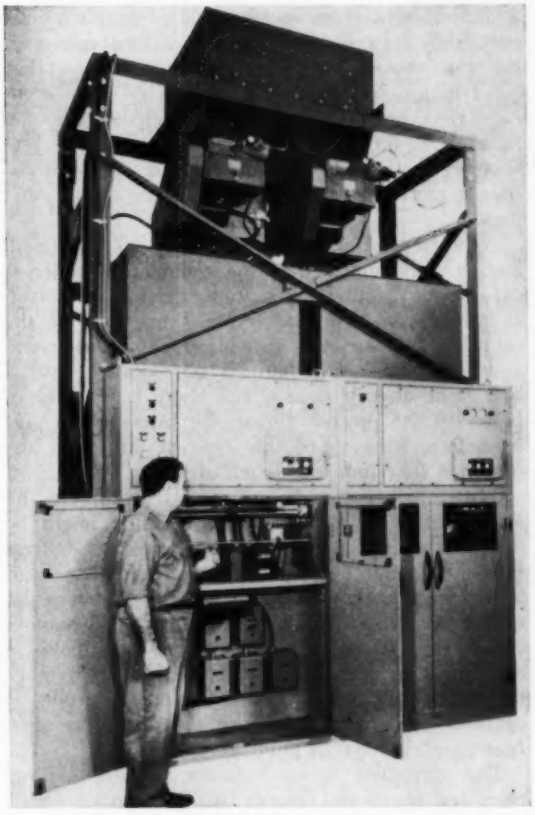


**Fig. 5—Duplex arrangement for handling carbon black permits automatic filling of one weigh hopper while other hopper is being emptied by a rotary feeder under loss-in-weight type control.**

tuating back pressure. To correct this condition he puts in a pressure regulator.

After startup, there is evidence of a very gradual decrease in the proportion of liquid fed, followed by a sudden increase. Another look at the system reveals that the storage tank is the culprit. When the tank is full, there is a high head against pump suction; when the tank is nearly empty, there is almost no positive head against the pump inlet. To cure this, a constant-head tank is installed, *Fig.* 1*b*.

The process then operates satisfactorily, except that the customer changes his specifications. He is no longer satisfied with a proportioning accuracy of plus or minus 2 per cent. It is decided that the V-belt drive from the motor to the variable speed transmission must be slipping occasionally, so a positive chain drive is installed. Then the electrician suggests that the voltage to the motor might not be constant (as when a 200 horsepower extruder is placed on the line). A synchronous motor is then substituted in the drive system.

Now, progress is being made! Or it was until winter came along. The liquid is shipped in tank cars and stored in tanks out of doors. When transferred to the day tanks, the drop in temperature has changed the viscosity somewhat and the density considerably. A thermometer is put in the line and it is noted that there is a big fluctuation in temperature between early morning and end of the shift. A temperature indicator and controller are added, *Fig.* 1*b*, with heating elements to maintain a constant temperature in the constant-head tank.

By this time the customer for the product is supplying it to one of the manufacturers of solid rocket propellants. When the rocket people said they wanted errors no greater than ½ per cent, they

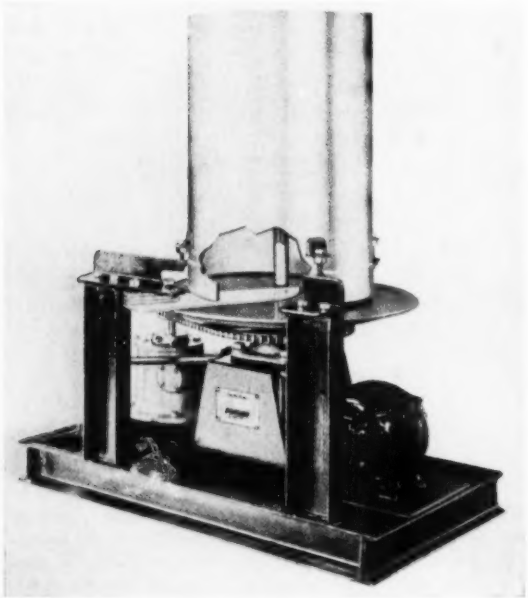
**Fig. 6—Feeding system for hydrogen cyanide is loss-in-weight type. Sodium cyanide is kept under 60 psi air pressure to force the hydrogen cyanide from the supply tank, bottom, to the point of application.**

didn't mean a given weight plus or minus ½ per cent, they meant a K-sigma of plus or minus ½ per cent based on 36 consecutive samples taken for 1-minute periods. To take care of these accuracy requirements, the process engineer adds an agitator in the constant head tank, *Fig.* 1*b*. This supplies the gear pump suction line with material that is more uniform in viscosity, temperature, and pressure.

Now all contingencies seem to be taken care of, and it is assumed that the volumetric feeder is capable of supplying accurate weights. However, a failure occurs in the form of breakage of the coupling between the variable speed transmission and the pump. The fault is not located until a half hour after it occurs, and there is no flow of liquid to the process during the interval. To give immediate warning of this type of failure in the future, a flow indicator is added to the system.

When the process is enlarged, it occurs to the process engineer that a simpler method might be found to control the gear pump so that it delivers the right amount of material. Since feeding is to be by weight, the storage tank is placed on scales and a weight controller used, *Fig.* 1*c*. A motor-driven rate setter connected to the scale poise is arranged to retract the poise at the rate (by weight) that the liquid is to be pumped. The controller is operated by a sensing unit on the tip of the scale beam, and controls the pump drive speed.

The controller is an indicator-recorder-totalizer type, and shows the pounds fed, the rate for which the loss-in-weight controller is set, and the position of the scale beam. An extra pen in this unit records the loss of weight in the storage tank to show that the weight of material that was supposed to leave this tank has in fact been withdrawn.



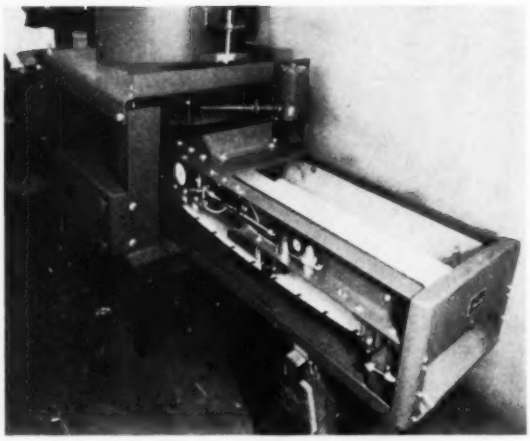


**Fig. 7—Table feeder, left, feeds wet filter cake from storage bin to stream weighing controller, foreground. Controller adjusts table rotational speed so that proper weights of material are fed.**

## ▶ Mass Measuring Devices

The most reliable, accurate, widely used, and yet simple mass measuring device is a scale. The two most familiar are the beam batch scale and the continuous belt scale. When either of these is used as a controller to direct various feeding devices, mass metering or mass flow control is established and good accuracy is possible.

In the loss-in-weight type gravimetric controller, or beam batch scale, *Fig.* 2, the container is placed on scales and the poise moved along the beam until balance is established. The poise is then uniformly and continuously retracted by means of a lead screw at the rate at which material is to be fed from the container. An electronic, pneumatic, or mechanical controller, operated from the tip of the scale beam then controls whatever feeding mechanism is appropriate to transfer material out of the container at the rate required to keep the scale beam in null or balance position.

Extremely accurate rates can be obtained with this type of controller and, since it inherently has a memory, accumulative errors are avoided. Scales may be mechanical lever type, pneumatic, electronic, or a combination.

In the continuous belt scale, or stream weighing controller, *Fig.* 3, material is conveyed at a uniform rate over a weighing section. The mass of material in the weighing section is continuously sensed by mechanical, pneumatic, or electronic means. The stream weight per foot on the conveyor is compared with the desired weight by the

**Fig. 8—Cut-away diagram illustrates mechanical features of a table feeder for cohesive materials. Walls of bin (above tabletop) may be vertical or slope outwardly from the top.**

scales. If there is a deviation, an error signal from the controller causes a correction in the feeding mechanism so that it will deliver the proper mass of material to the conveyor. Weight of material per foot on the conveyor is integrated with conveyor speed to give the total weight of material delivered. The stream weighing controller is suitable for solid materials only, whereas the loss-in-weight controller can be used for either liquids or solids.

Two other mass measuring devices should be mentioned. The so-called mass meter measures the energy used to accelerate material to a known velocity, or to decelerate it from a known velocity to zero. The atomic meter measures the absorption of gamma particles by material moving between a gamma emitter and receiver. This actually measures density and, if velocity is known, mass can be obtained inferentially.

## ▶ Application Examples

In the following descriptions of feeding mechanisms and the difficult materials that they handle, the two major types of gravimetric devices will be referred to respectively as loss-in-weight controllers and stream weighing controllers.

**Chicle.** In chewing gum manufacture, the problem of continuously feeding chicle accurately was a sticky one. The first step was to put the chicle into an insulated vessel with steam-jacketed pipelines so that it could be softened and handled as a liquid.

A large gear pump was selected which was driven at relatively slow speeds by positive variable-speed drive under the command of a loss-in-weight controller. A helical gear pump was used to reduce pulsations that would be encountered with a straight spur gear pump. Rate of feed is adjustable from a control panel over a wide range and, of course, recorders, totalizers, and indicators were used to display to the process engineer the past results and present performance, and to indicate future trends of the process.

**Extracts.** Volatile incense is proportioned to chicle by a valve or a gear pump. In this case the gears are small, and the speed is such that pulsations are not a factor. The illustration of *Fig.* 4 shows the flavoring tank mounted in a loss-in-weight controller. An air pressure of 5 psi is maintained in the tank to force the liquid through the valve to the point of application in the process.

These two illustrations give some idea of the capacity ranges encompassed by loss-in-weight controllers. These are not the extremes by any means. The gear pump for the chicle has 8-inch diameter connections and the unit on the flavoring valve has a one-tenth inch orifice, a ratio of 6,400:1.

**Carbon Black.** This material is obtained by burning natural gas with a deficiency of oxygen. Although it is pelletized for handling, there are plenty of fine particles left by the time the material has been shipped to the point of use and conveyed into storage bins. Its compressibility factor is about 20 to 35 per cent, which means the weight per cubic foot may vary from 20 to 30 pounds. It is necessary to confine the material closely—treat it like a liquid—or the plant in which it is used and much of the surrounding neighborhood will soon take on hues ranging from inky black to gray. Since the material will flood, it must be handled in a rotary type feeder, and the controller, of course, must be the loss-in-weight type.

The illustration of *Fig.* 5 shows a duplex installation which provides for one of the weigh hoppers to fill automatically while the other is being emptied by the rotary feeder under loss-in-weight control.

The duplex arrangement is necessary because the carbon is so light, and used in such great quantities, that a single hopper would be extremely large, requiring an expensive structure to house it. Also, considerable time would be required to refill the hopper. During this time, the controller would be inoperative and feeding would be volumetric.

Certain cohesive materials will not leave the rotor pockets with regularity. The loss-in-weight gravimetric controller regulates the speed to compensate for this, but less burden is put on the controller if means are provided for emptying the pockets uniformly.

**Latex.** This liquid is proportioned to dry carbon black to make good, tough tire rubber. Latex is

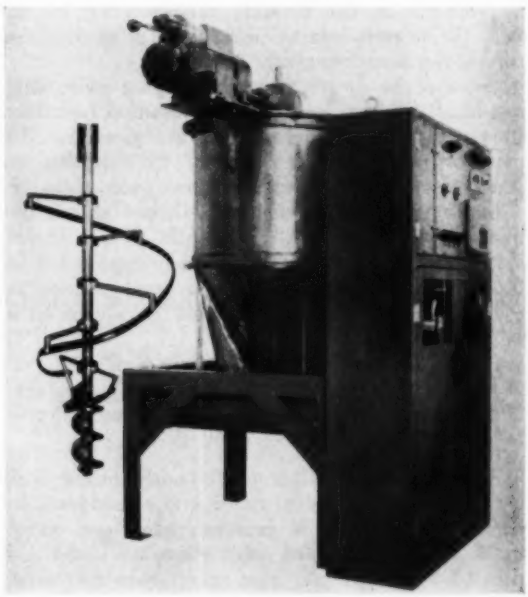


**Fig. 9—Spiral assembly, removed from hopper of nitrocellulose feeder shown, continually lifts and fluffs cotton-like material to prevent arching. Feed screw at bottom of spiral assembly forces material through a tube to a loss-in-weight controller.**

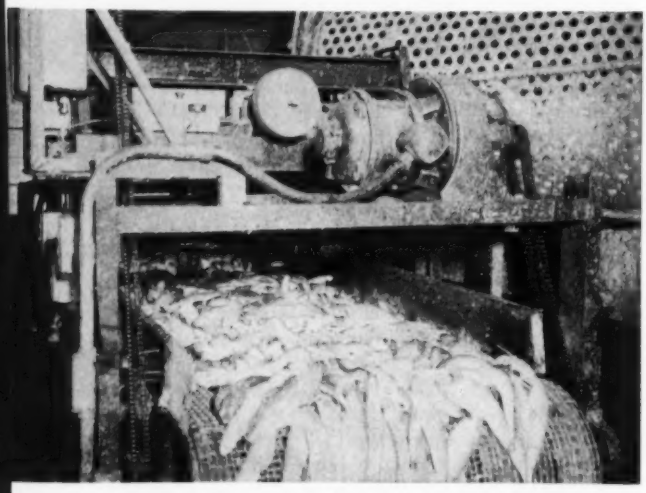


Fig. 10—In proportioning weights of fish during manufacture of pet food, a stainless steel belt is used from which water can drain off before the fish reach the weighing point. Belt is an integral part of a stream weighing controller.

classed as a difficult material because of its varying specific gravity and its tendency to come out of solution and gradually build up in valves, fittings, and pipe lines. The material is pumped by open impeller pumps running at reasonably low speeds. In this application a loss-in-weight type controller is used.

**Nickel Carbonyl.** This is a catalyst that is explosive and highly toxic. It is normally stored under a positive pressure of about 80 psi. If it escapes to the atmosphere it will explode. It is so poisonous that the weigh tanks are located in a windowless, reinforced concrete building which is kept under partial vacuum and the exhaust is burned. No one is permitted in the building during operations; in fact, the nearest human being is in a block house several hundred feet away.

Because the air motor-operated plug valve that regulates the flow is also a few hundred feet from the supply tanks, the controls are electronic. In view of the accuracies required, the lag time in pneumatic lines this long was not permissible.

Instrumentation in the block house shows the amount of material in each tank of the duplex system, the rate of feed, the total amount fed in hundredths of a pound, and the exact position of each scale beam. The amount fed is printed on a tape every four minutes.

Here is an example of a pressurized material that is so hazardous, so poisonous, and so explosive that automation *must* be used to the maximum degree to protect plant personnel from its dangers.

**Asphaltum.** Asphalt is continuously mixed with carbon, which is then extruded into electrodes. The asphalt is melted and pumped into open weigh tanks that are jacketed with steam at about 250 psi. All lines, and the gear pump used for transporting and measuring the hot material, are also steam jacketed. The pump is driven by a variable speed drive with automatic control. Both the viscosity and specific gravity of the melted asphalt can vary widely, so that loss-in-weight control was indicated.

**Hydrogen Cyanide.** A dangerous material, hydrogen cyanide can be handled by loss-in-weight techniques. In operation, a loss-in-weight controller pneumatically senses the scale beam position and controls the feed safely and accurately. Sodium cyanide is kept under 60 psi air pressure to force the hydrogen cyanide to the point of application. The weigh tank is shown suspended from the scale beam in the loss-in-weight controller, *Fig.* 6.

**Filter Cake.** In some continuous ore refining processes, wet filter cake, or ore, is stored in bins which require extremely large openings to avoid arching; yet the rate of feed requirements are relatively small. Table feeders are used to withdraw material from the bins. The tables may be from 2 to 7 feet or more in diameter. As the material is discharged from the rotating table, *Fig.* 7, it falls onto a belt type stream weighing controller which adjusts the speed of the table so that it delivers the exact weight called for. It would probably be cheaper to raise and lower a feed gate or to change the setting of a plow to obtain weight regulation. But when the feed rate is slow, the time delay involved with these methods would be detrimental to good control. Changing the speed of the table gives more accurate control.

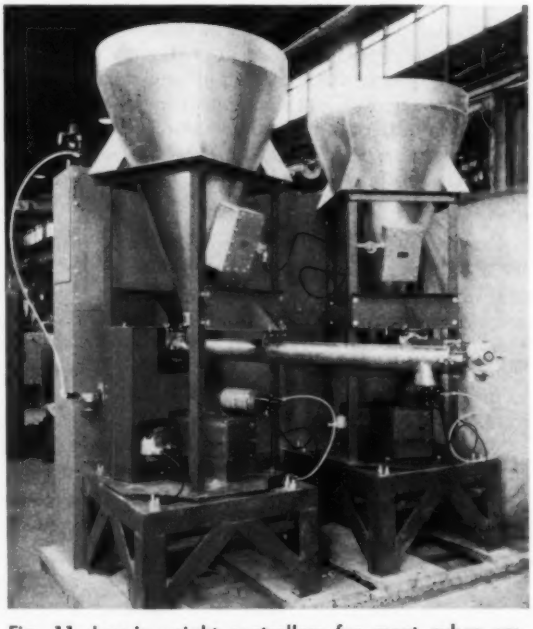


Fig. 11—Loss-in-weight controllers for meat cubes employ stainless steel hoppers and screw conveyors. Units of this type are also suitable for feeding controlled amounts of photographic chemicals where product contamination must be avoided.

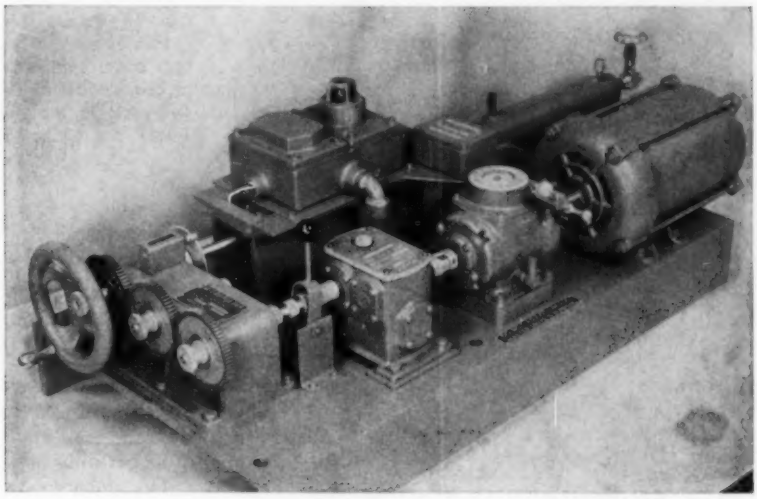


**Fig. 12—Volumetric feeder is used to feed small quantities of liquids against pressures as high as 3500 psi. Unit employs a plunger driven by a lead screw to obtain accurate metering of fluids.**

Because of the very cohesive nature of some of the material, it is necessary to use an unloader or chopper to obtain uniform delivery to the weigh belt when the table is rotating at slow speed. It is impossible to obtain close control of a continuous process when material flows to the controller in slugs. The table feeder of *Fig.* 7 is equipped with an unloader delivering to the stream weighing controller. In *Fig.* 8 is shown a feeder for cohesive materials. The bin wall is vertical, or may slope outwardly from the top.

**Nitrocellulose.** This material looks and acts like cotton. The weight is approximately four pounds per cubic foot. A special feeder has been developed, *Fig.* 9, that uses a large spiral operating at the periphery of a hopper. The spiral continually lifts the material upward, turning it over and over and fluffing it so that it will not arch. This is called the fluffer. At the bottom of the hopper is a large polished feed screw running in a nylon tube which feeds material out of the hopper by forcing it down through the tube. The material is so light that it seemed impractical to use a stream weighing controller, therefore, a loss-in-weight controller was used.

**Food Products.** It is claimed that more pet food is canned than any other food product. One of the ingredients is fish, and the tonnage is so great that processing must be at high rates on a continuous basis.

In some plants, the smaller fish are handled by pumping them in water. The fish are weighed on a special type of belt conveyor, *Fig.* 10. It is a stainless steel mesh belt which permits water to drain off before the fish reach the weigh span.

Meat cubes, on the other hand, can best be fed into continuous hash cookers by stainless steel screw conveyors feeding from stainless steel hoppers with loss-in-weight controllers. Such an arrangement is shown in *Fig.* 11. As an aside, photography developer chemicals that do not permit the slightest degree of contamination are also fed with equipment of this type.

**Small Feeds.** Another interesting feeder was designed to solve a feeding problem that was difficult because of the conditions imposed rather than the material to be fed. In this application, it is necessary to feed 5 ml per hour of a liquid at an absolutely uniform rate against a pressure of 2,000 psi. This is done with equipment such as that shown in *Fig.* 12, which is basically a giant hypodermic needle. The unit has a stainless steel cylinder, Teflon seals, and an accurate lead screw drive for a plunger that includes a synchronous motor and variable speed transmission. A counter may be geared to the lead screw to read in hundredths of a ml. Actual ranges available are from 1 to 800 ml per hour, with pressures up to 3500 psi.

In petroleum laboratories, permeability tests are run on rock cores by injecting oil into the cores at a known rate and measuring the pressure.

In a large dairy, vitamin oils are injected directly into a milk stream to fortify milk after it has been irradiated.

Some theaters with air conditioning may, at certain times, recirculate as much as 60 per cent of the air in the theater, bringing in 40 per cent fresh air. In at least one instance, equipment of the type shown in *Fig.* 12 is used to inject a few ml per hour of antitoxin into the air stream.

**Slurries.** Activated carbon slurries have been found quite difficult to feed accurately. Equal volumes of activated carbon and water produce a slurry which is quite thin and flowable. The carbon is so abrasive, however, that it cannot be handled in gear pumps and even a pump with hardened rotor and resilient rubber stator gradually loses its capacity. Ordinary control valves and meters become clogged in short order.

The rotary dipper feeder, *Fig.* 13, is a volumetric feeder that will easily feed this material. The dipper wheel has eight dippers, each holding one

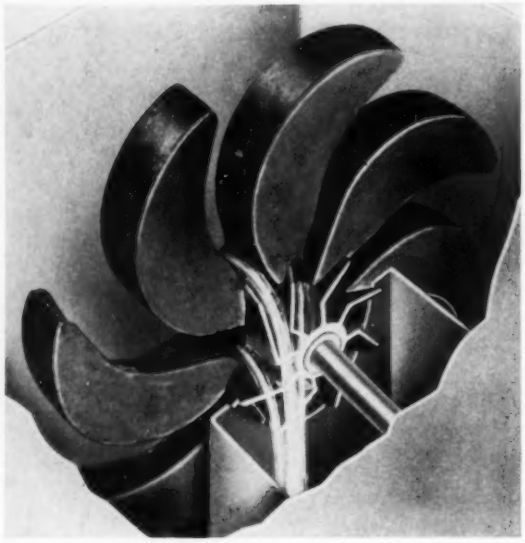


Fig. 13—Rotary dipper feeder is useful for handling materials such as slurries containing abrasive particles that could settle out in pumps and valves. Material is picked up by dippers from one side of a baffle and delivered to the other side at a rate proportional to wheel rpm.

pint, so that it delivers exactly one gallon per revolution. The slurry is picked up by the dippers from one side of a baffle and delivered to the other side from a point near the center of the wheel. The liquid level need not be accurately maintained because the dippers always go below the surface. Any excess material is spilled over a constant level. Delivery, of course, is proportional to wheel rpm. A drawback of the device is that it is essentially a gravity feeder. However, it is possible to arrange it to feed against pressure.

When extremely accurate feeding of slurries is required—as is the case with certain solid rocket propellant ingredients—the loss-in-weight controller is used. The slurry is pressurized in agitated tanks mounted on scales, and Saunders type control valves with rubber linings are generally used. Nitroglycerine may be fed with this system.

**Tobacco.** Tobacco leaves are difficult to feed. The center cuts of the leaves may weigh from 2.5 to 8 pounds per cubic foot depending on moisture content and twist. To provide the required volume to get sufficient weight on a belt for good control, the belts may be up to 48 inches wide. Usually, the belts are made from three-ply Neoprene impregnated duck. This is a thin belt but, even so, it weighs more per foot of length than the load of tobacco being weighed on it. The belt is made without any rubber or Neoprene covering to avoid rubber crumbs in the product.

The tobacco feeding mechanism that supplies the stream weighing controller, *Fig.* 14, includes a rectangular bin 4 to 8 feet wide with a live bottom consisting of a conveyor belt. This belt brings the material to one side of the bin, which is actually a sloping conveyor. The latter conveyor has slats across it with spikes protruding from the slats. This spiked slat conveyor slowly drags the leaves to the top of the bin where a rotating doffer knocks them off onto the conveyor belt. The speed of the live bottom and wall of the feeder is controlled to deliver the desired weight of leaves.

At this point, a very primitive type of feeder control that is used earlier in the process will be described. Hogsheads of tobacco are brought in on pallets and placed beside a conveyor belt. This tobacco has been in storage to age from 3 to 5 years. Apparently no one has found a way to separate the compressed hands of tobacco from the stack mechanically without tearing the leaves excessively. Therefore, workers stand between the pallets of tobacco and the conveyor belt and manually strip the hands from the stack and lay them neatly crosswise of the conveyor. The conveyor moves the tobacco hands between knives which cut off

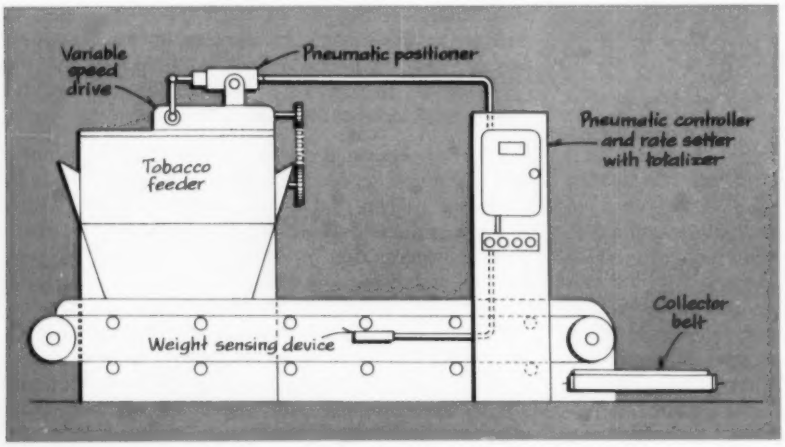



Fig. 14—Tobacco feeder, left, supplies tobacco leaves to continuous belt scale in accordance with commands from pneumatic controller and rate setter.

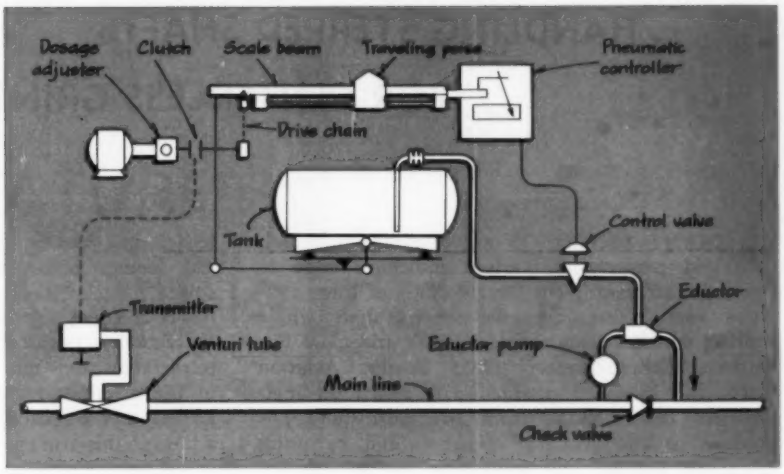



Fig. 15 — Diagram illustrates major components used in system for automatically adding preset proportion of tetraethyl lead to gasoline flowing in main line. Loss-in-weight type control is employed.

the tips and the stalk stems, each of which go separate ways on individual conveyors. The center cuts drop onto a weigh belt.

The weigh belt operates a large *"Stop* and *Go"* indicator that has red, orange, and green signal lamps that the operators can see. Their task is to keep the orange light going all the time. Green means speed up—not enough center cuts reaching the weigh belt—and red means slow down. This is an example of a material that is so difficult to feed that as yet the process has not been automated.

**Tetraethyl Lead.** This material, which shall be referred to as T.E.L., is hard to contain, volatile, and can't be pumped in proportioning reciprocating pumps. After several people died as a result of contact with T.E.L., E. I. du Pont de Nemours & Co. Inc. process engineers passed the problem of safely handling it to their medical department.

The medical department promptly decreed that T.E.L. was not to be handled by anybody! Therefore, antiknock addition is now automated, and most gasoline is treated with T.E.L. so that neither material gets out of the pipeline.

The gasoline is metered in pipelines ranging from 6 to 20 inches, and a rate of flow signal is used to set the lead screw speed on a loss-in-weight controller to match the flow of gasoline, *Fig.* 15.

T.E.L. is contained in a steel tank mounted on a scale of anywhere from 30 to 110 tons capacity. The T.E.L. is fed from the tank under vacuum. Flow is induced by an eductor operated by recirculating part of the gasoline out of the pipeline, through the eductor, and back into the pipeline.

A motorized control valve on the suction line from the tank controls the treatment. The rate of treatment in cc per gallon is set with a dial on the loss-in-weight controller. Piping and circuits are standardized, and to make a single change in valve or fitting requires approval of the medical department.

## ▶ Conclusion

There are many feeding mechanisms and devices for regulating the flow of solid or liquid materials that do the physical transferring from storage to process satisfactorily. These are volumetic measuring devices. When accuracy of feed by weight is desired, some type of gravimetric controller is required for these feeding mechanisms. Two major types of gravimetric controllers have been described. One or the other will fulfill almost any feeder control requirement regardless of the feeding characteristics of a material.

The loss-in-weight controller will control feeding mechanisms for either solids or liquids with extremely high accuracies and, since it has a memory, it cannot have accumulative errors. Instrumentation techniques are readily applied to loss-in-weight controllers.

The continuous stream weighing, or conveyor scale, type controller will control solids feeding mechanisms only. There is some saving in head room with the stream weighing controller over the loss-in-weight type. The former device is especially suited to the control of large streams, although it will control small streams.

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# HANDLING STEPPED SHAFTS FOR CENTERLESS GRINDING

MANY SYNCHROS are used to turn dials and pointers on various indicators used in aircraft instrument panels. Each of these synchros uses a multidiameter output shaft whose bearing surfaces require fine finishes and close tolerances. Eclipse-Pioneer Div., Bendix Aviation Corp., has increased production of shafts for their synchros by switching from two burnishing operations to one grinding operation and by using automatic loading and unloading on the grinder.

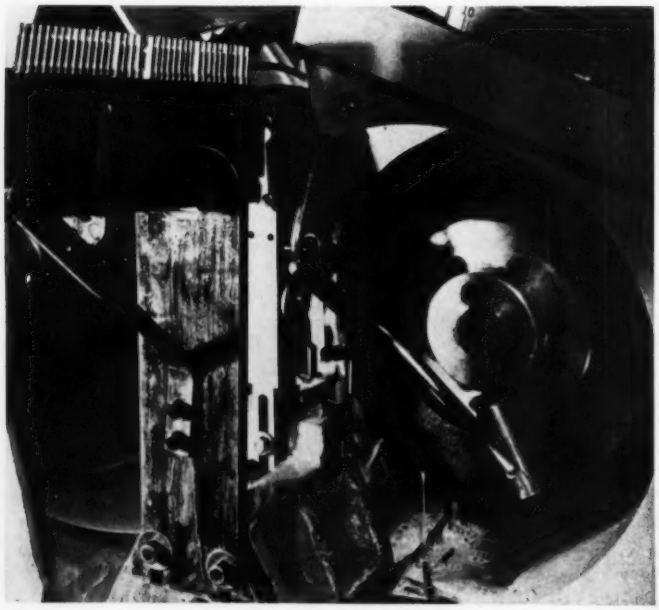
When bearing surfaces were finished by burnishing, the shafts were turned to a tolerance of 0.0002 inch on a Swiss automatic. Only 50 of the turned shafts could be finished per hour by a manually fed burnishing machine, which required a skilled burnishing operator, and 100 per cent inspection of the shafts was necessary.

For the grinding method, a tolerance of 0.0005 inch is good enough on the parts turned by the Swiss automatic. The turned parts are automatically fed one at a time into grinding position on a centerless grinder built by Van Norman Machine Co., a division of Van Norman Industries Inc. The shaft is ground and automatically unloaded. Production rate is 600 shafts per hour. Since holding of tolerance no longer depends on a burnishing operator's skill, 100 per cent inspection is no longer required.

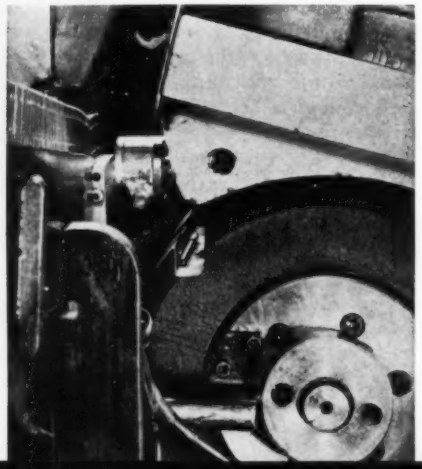
Parts are fed to the grinder by a vibratory bowl feeder and feeding system suggested by the assistant factory manager on motor production. The shafts hang vertically from a shoulder and move down a gravity chute from the feeder. Shafts are individually released from the feed chute by a retractable stop pin. An actuating cam attached to the grinder's regulating wheel strikes a spring-loaded arm on each turn of the wheel. Through a linkage this arm controls the stop pin.

For each revolution of the regulating wheel, the stop pin allows one shaft to move down to a horizontal position on a work rest between the regulating wheel and the grinding wheel. A cutout in the work rest locates the shaft endwise ready for grinding. The grinding wheel, rotating at a different speed from the regulating wheel, forces the shaft against the work rest and the regulating wheel and removes excess stock. The regulating wheel assures constant uniform rotation of the workpiece and determines the speed with which the work revolves.

Across the face of the regulating wheel a notch has been cut. When the notch comes into position at the work rest, the ground shaft rolls off the work rest and into the notch. The regulator wheel then carries the shaft up and away from the grinding wheel and drops the shaft into a pan. Meanwhile, the next shaft is fed onto the work rest and the cycle repeats.



**General photograph shows synchro shafts feeding down chute from upper left to be positioned on work rest between regulating wheel at right and grinding wheel in left background. Cam on the regulating wheel has just begun engagement with trip arm to release the next workpiece to the grinding position. Close-up shows a ground shaft being carried away from the grinding position by the notch in the regulating wheel.**



# TEMPERATURE MEASURING DEVICES

**Necessity for accurately measuring temperature pervades all of industry. Knowledge of the operating principles, advantages, limitations, and applications of the many available types of temperature measuring devices is essential to proper selection for a given manufacturing process. The author covers these points in a comprehensive survey of the broad field of temperature measurement.**

By **J. J. COMBES,** Project Engineer, Scientific Design Co. Inc., New York, N. Y.

BASIC to automatic control of any industrial process is the requirement for gathering accurate information on pertinent variables that affect the desired end result. Among such variables, temperature is one of the most common encountered in industry. The need for control of temperature is seen in the processing of metals, foods, plastics, ceramics, chemicals, textiles, and a multitude of other products. Typical operations that require temperature control include heat treating, melting, vaporizing, and cooling.

Consideration of the importance of temperature control in the operation of a continuous chemical process will point up the need for accurate measurement of this parameter. The discussion will apply whether the materials are in the form of gases, vapors, liquids, or semifluid solids. They may be pumped, blown, or conveyed through the process in pipes, ducts, chutes, or on moving belts.

When a process material undergoes chemical change or change of state, energy in the form of heat must usually be transferred. This is true for changes involving reaction, polymerization, cracking, vaporization, condensation, crystallization, and sublimation.

In an endothermic chemical change, heat must be supplied continuously at a controlled rate in order to maintain the reaction. In an exothermic chemical change, heat must be removed continuously from the process in order to keep the reaction from proceeding too rapidly. When a material

is changed from a less to a more active state, as in melting a solid to a liquid or vaporizing a liquid to a gas, heat must be transferred to the material to cause the change to take place. For process stability and uniform flow of materials, these heat transfers must be conducted at controlled rates.

## ▶ Temperature Measuring Elements

When energy in the form of heat is transferred to a body the temperature of the body rises unless it is at or reaches the temperature at which a change of state takes place. In the latter case the temperature remains constant while the change of state is taking place (at constant pressure), and the temperature begins to rise again after the change of state is completed. In addition to the rise in temperature, other effects result whose magnitudes are proportional to the temperature causing them. These effects, upon which most temperature measuring devices are based, are listed under "Effect Sensed" in TABLE 1.

In addition to being a function of the temperature causing them, these effects are frequently linear and usually reproducible unless, as in some types, the increased temperature has caused an irreversible chemical reaction or physical change of the temperature measuring element.

Equipment for measuring temperature continuously in ranges falls into two broad types. In the more common type the measurement is direct in that the measuring element is subjected to and attains the temperature it is measuring. This type of element employs principles of operation such as 1 through 5, TABLE 1. The less common, indirect type "sights" upon a hot object and measures its temperature from some property (intensity or brightness) of the radiant energy received. This type of element makes use of effects 6 or 7, TABLE 1, and is usually used in the higher ranges where the temperatures would destroy the direct type of element before it attained the temperature it was measuring.

Another type of temperature measurement does not continuously indicate the temperature being measured but rather indicates when a certain predetermined maximum temperature has been reached. This type of measurement makes use of effects 8 or 9, TABLE 1.

The effects described under 10 in the table are not, at the present time, used as an operating basis for any thermal element but can be used by means of certain manually performed test measurements to roughly determine the temperature of, or the maximum temperature reached by, a body in question.

## ▶ Error Sources And Countermeasures

Although temperature measurement is relatively simple as compared, say, to flow measurement, there are many conditions that can cause errors in making temperature measurements. By taking proper precautions, most of these conditions can be eliminated or at least minimized.

In most process plants the direct measurement of temperature, as previously described, is most frequently used. This means that the temperature element must be inserted right into the process materials. Most thermal elements are relatively fragile and must be protected from process conditions of corrosion, high pressure, high velocity flow, abrasive materials, and poisons (e.g., those causing hydrogen embrittlement of thermocouples). This protection is supplied by means of thermal wells which, in addition to protecting the thermal elements, allow them

**TABLE 1—Basic Principles of Major Types of Temperature Measuring Elements**

| Type of Measurement | | Effect Sensed |
|---|---|---|
| Continuous indication of temperatures within a range | Direct measuring | 1. Changes in liquid volume<br>2. Changes in liquid or gas pressure in a closed system<br>3. Differential changes in size of two different metals<br>4. Changes in electrical resistance<br>5. Changes in voltage generated by dissimilar metals connected in a thermocouple circuit |
| | Indirect measuring | 6. Changes in intensity of emitted radiation<br>7. Changes in brightness of emitted radiation |
| Indication of predetermined, discrete temperatures | | 8. Changes in color<br>9. Changes in physical state |
| Either continuous or discrete temperature indication | | 10. Changes in other physical properties such as hardness, stiffness, elasticity, crystal structure, etc. |

to be removed for repair or replacement.

The use of thermal wells, however, will cause errors or lags in indicated temperature when fluctuating temperatures are being measured. For example, rising temperatures will read low and falling temperatures will read high. This is because of the insulating effect of the wells themselves and the fact that the temperatures indicated by direct-measuring thermal elements are actually the temperatures of the elements themselves rather than the temperatue of the material being measured. This type of error can be minimized, but not eliminated, by: 1. Manufacturing the well of materials having the highest conductivities that the process conditions will permit. 2. Obtaining the best physical contact possible between the thermal element and the inside of the well (usually accomplished by using soft aluminum foil inserts or filling the well with a heat conducting liquid). 3. Using a well with fins for maximum heat transfer area when process conditions permit.

Another cause of error in the direct measurement of temperature lies in the thermal system itself. This error is unrelated to thermal conductivity, physical contact, or surface area. The mass acts as a thermal capacity and causes the temperature of the thermal element to lag behind the temperature of the material being measured. This error can be minimized by minimizing the mass of the thermal element, its protecting well, etc.

Another means of minimizing the error or lag in measuring a changing temperature is to introduce derivative or "rate" action into temperature transmitting devices. This action "fools" the receiver into indicating closer to the true temperature because the transmitter transmits a temperature signal higher or lower (depending on whether the measured temperature is rising or falling) than its own element temperature. This "advanced" temperature signal has the effect of overcoming lag and therefore provides an indication that is closer to the true temperature.

In temperature control, a means of minimizing the effect of lag on temperature upsets is to eliminate as many as possible of the process upsets before they are able to affect temperature. For instance, suppose the temperature at the outlet of a heat exchanger is controlled by regulating the flow of heating steam to the exchanger. With temperature controlling the flow of steam directly, a drop in supply pressure of the steam would cut down the flow of steam to the exchanger because of less available pressure drop across the control valve. This would start to lower the exchanger outlet temperature. The controller would then gradually open the steam valve to bring the temperature back to normal but, due to measurement lag, the actual temperature would drop lower than it would have had there been no lag. On climbing back up, the temperature would probably overshoot the control point.

Now suppose the flow of steam to the exchanger is regulated by a flow controller, with the exchanger outlet temperature controller resetting the control point of the flow controller. A drop in steam pressure would still cause a drop in steam flow, but the steam flow controller would detect this almost immediately, there being essentially no lag in flow measurement. Thus, the steam flow would be corrected before any measurable temperature change occurred. This is a type of "cascade" control that is used to prevent temperature upsets and therefore minimize the effects of lag on temperature control.

**TABLE 2—Checklist for Temperature Measuring Equipment**

1. Will it do the job (make the measurement under process conditions)?
2. Initial cost.
3. Maintenance cost.
4. Ease or complexity of installation.
5. Range of temperature to be measured.
6. Materials of construction.
7. Protection required for the element.
8. Range change requirements.
9. Availability.
10. Accuracy and reproducibility.
11. Distance from point of measurement to point of indication or recording of temperature.
12. Compatibility with existing instruments.
13. Anticipated life of the installation.
14. Experience and ability required of the personnel who will operate the instrument.
15. History and reputation of the device.
16. Experience and reputation of the manufacturer.

Additional causes of error which usually can be eliminated in the use of direct measurement type thermal elements are:

1. Element located too close to a heating or cooling coil so that it is influenced more by the temperature of the coil than by the over-all temperature of the process material itself. As a rule, the sensitive part of a thermal element must be mounted at least 6 inches from any heating or cooling coil in an agitated vessel, and at a greater distance if the vessel contents are not agitated.

2. Element mounted in a process dead spot, or stagnant area, where the process material does not reach the same temperature as the circulating or agitated parts of the process.

3. Element mounted in a vapor space whose temperature would, of course, be different from that of the circulating process liquid.

4. Element and well insufficiently immersed. At process temperatures above ambient, the well and extension will carry heat away from the element, causing it to read low. At process, temperatures below ambient, the well and extension will conduct heat to the element, causing it to read high.

5. Buildup of process materials on the well which will further insulate the element from the temperature it is measuring. This will cause the indicated temperature to lag still further behind the actual temperature when it is changing.

6. Exposure to extraneous temperature changes.

This is less likely to apply to process temperatures inside of vessels or equipment, but is a real source of error in applications such as heating, ventilating, and air conditioning.

In processing operations which are carried out in higher temperature ranges, the indirect means of temperature measurement must be used. Devices for this type of measurement are also subject to errors in their temperature indications, and the errors are usually much harder to eliminate or minimize than those in the direct-measuring type of thermal element. This is because the indirect temperature element will indicate the temperature it "sees," and this is frequently not the true temperature of the material the element is attempting to measure.

In measuring these high temperatures the instrument is sighted into the processing area. This is usually in some sort of combustion, reaction, or furnace area, and the nature of what goes on inside the area is what causes the errors. For example, when combustion takes place some smoke is generated. The smoke is usually opaque, and will cut down the radiation reaching the instrument and cause a low reading. In reaction processes operating at high temperatures, quite frequently opaque gases are produced which will have the same effect as combustion smoke.

When metals are melted the molten surface is usually covered by a slag or oxide film which is at a lower temperature than the molten metal itself and will, of course, cause a low reading. In addition, radiation from the furnace or vessel walls, which are usually at a different temperature than the hot process materials they contain, will be picked up by the instrument and will cause it to be in error.

One advantage of indirect radiation types of temperature elements is that they have essentially no lag. As soon as the intensity of the radiation that reaches them changes, they produce the new reading. There is no delay caused by heat transfer through insulating wells, and the temperature of the element does not have to rise to the new value.

## ▶ Automatic Control Problems

Temperature, if changing slowly or not at all, is one of the easiest physical measurements to make accurately if normal precautions are taken. At the same time, it is one of the hardest of process conditions to control. If a process temperature is being controlled it means that heat is being added to or removed from the process. Therefore the temperature is "live," or changing. Since the temperature is changing, transfer lags make it impossible to obtain the correct temperature indication at the instant the measurement is being made.

The indication of a rising temperature lags behind or is below the true temperature. Therefore, if the supply of heat is not cut back until the rising temperature indication reaches the control point on the controller, there will be considerable overshoot. This is because the actual temperature is higher than the control point when the controller cuts back on the heat supply (based on the temperature indication it receives from its thermal element). Thus, for close temperature control, it is necessary to use all three control functions—proportional, reset, and rate response.

If a temperature controller has been off the control point because of an upset, and is bringing the temperature back to the control point using the three modes of control, it begins to back off on supplying heat to the process as the temperature indication approaches the control point. This is in order to avoid overshoot since the actual temperature, when rising, is higher than the indicated temperature because of the transfer lag. If the indicated temperature is dropping or falling away from the control point, the actual temperature is lower than the indicated, and the controller will start increasing the heat supply rapidly, the rate depending upon the rate at which the temperature is deviating from the control point. The faster the deviation rate, the greater the rate at which the controller will increase the heat supply in order to bring the temperature back to the control point.

Temperature measuring equipment available today will provide adequate measurement for almost all temperatures encountered in industry. However, improvements can certainly be used that will lead to faster speed of response. Instruments are also required that can provide continuous readings with no manipulation in ranges above 7000 F.

In order to choose the most suitable device for a particular temperature measurement application it is necessary to know the basic design features, characteristics, advantages, and disadvantages of the various types of available temperature elements. Careful evaluation of these factors in relation to the check list of TABLE 2 will lead the instrument application engineer to make a wise choice. A description of the major types of temperature measuring devices is given in the accompanying pages under the three broad categories of direct, indirect, and discrete temperature measuring devices.

## 1 DIRECT TEMPERATURE MEASURING DEVICES

### LIQUID IN GLASS

This type of device measures temperature as a function of the change in volume of a liquid as it is subjected to a change in temperature. It is made of a relatively thick-walled, long glass tube with a hollow bulb on one end. The bulb communicates with a blind capillary bore in the center of the tube. The bulb, whose volume is large in comparison with that of the capillary, is usually filled with mercury, mercury-thallium, gallium, alcohol, toluol, pentane, or silicones.

As the bulb is subjected to a change in temperature its liquid also changes temperature. This changes the volume of the liquid, causing it to rise or fall in the capillary bore of the tube. The height of the liquid in the bore, compared to a calibrated scale on or next to the tube, is then an indicator of the measured temperature.

Approximate limits of operation are from minus 300 to plus 1200 F. This type of temperature gage is probably the most widely used in industry, laboratories, and by the general public.

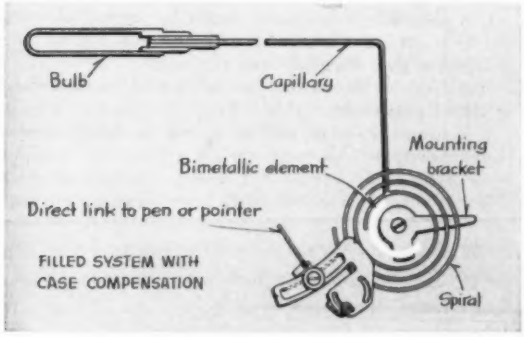
**Advantages**

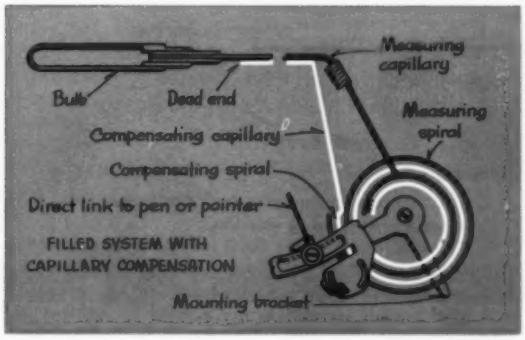
1. The liquid in glass thermometer is relatively inexpensive (depending upon the accuracy required).
2. It can be manufactured to indicate temperature to a high degree of accuracy.
3. It is highly sensitive to temperature changes.
4. It is direct-reading and requires no other equipment or outside power.

**Disadvantages**

1. The liquid in glass thermometer is fragile, easily broken, and cannot be repaired. Industrial types can be protectively armored but cannot be completely protected—they still have to be read.
2. It cannot be remote indicating.
3. It cannot record, although some versions can indicate the highest and lowest temperatures measured.

## FILLED SYSTEMS




*Courtesy, Minneapolis-Honeywell Regulator Co.*

A filled system consists, basically, of a bulb subjected to the measured temperature, a flexible connecting capillary, and an elastic element; all filled with a material responsive to changes in temperature. There are two types of these temperature elements:

1. *Volume Responsive.* This type is completely liquid filled. The liquid expands on rise in temperature, and the net volume change is taken up by the elastic element. The accompanying pressure change is secondary.

2. *Pressure Responsive.* This second type of filled system is partially filled with a volatile liquid or completely gas filled. Pressure in the system increases on rise in temperature. Pressure change expands the elastic element; the volume change is secondary.

Each type of filled system has been separated into two classes by the Scientific Apparatus Makers Association. Volume responsive devices include liquid filled (Class I) and mercury filled (Class V) types. Pressure responsive devices are either vapor filled (Class IIA, IIB, and IIC) or gas filled (Class III).

*Liquid Filled—Class I.* Range of operation is minus 300 to plus 600 F. The minimum span of 25 to 50 F is limited by bulb size. The maximum span of 250 F is limited by the nonlinear expansion characteristics of the filling liquid. The speed of response is relatively slow because of low thermal conductivity and system heat capacity.

*Mercury Filled—Class V.* Range of operation is from minus 38 to plus 1200 F. The minimum span is 40 F. The maximum span is limited only by the range. The speed of response is relatively slow.

*Vapor Filled—Class II.* Range of operation is minus 300 to plus 600 F. Instruments in this class are divided into three subclasses as follows:

IIA is used when the bulb temperature will always be higher than the ambient temperature. A large bulb contains vapor and volatile liquid; the capillary and elastic element are filled with volatile liquid.

IIB is used when the bulb temperature will always be lower than the ambient temperature. A small bulb contains volatile liquid and vapor, and the capillary and elastic element contain vapor.

IIC is used when the bulb temperature might be either higher or lower than the ambient temperature. The filling material can be located as in either IIA or IIB. Changeover can require from several minutes to an hour.

*Gas Filled—Class III.* Range of operation is from minus 450 to plus 1000 F. Span is limited only to that required to ensure reasonable linearity. This type requires a relatively large size bulb, but its speed of response is very fast.

**Advantages**

1. A filled system may be made remote reading up to 150 feet from the bulb.
2. It provides power for driving an indicating pointer or recorder pen.
3. It is the least expensive of the three remote reading temperature measuring systems (filled systems, resistance thermometers, and thermocouples).

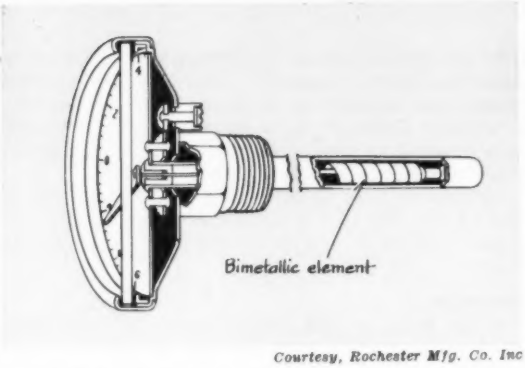
**Disadvantages**

1. The filled system, except for the gas filled type, is relatively slow in response.
2. Liquid, mercury, and gas filled systems, Classes I, V, and III, require compensation if the ambient temperature is variable. Full compensation (separate system including capillary and elastic element) is required if case and capillary temperature will be different. Case compensation (usually a bimetallic element) is required if case and capillary temperature will be the same and the capillary length is not more than 20 feet.
3. Its remote reading distance is limited.
4. System is difficult to repair if it is damaged so that it leaks, and usually must be returned to the vender for repair.

## BIMETALLIC THERMOMETERS

These devices measure temperature as a function of the differential change in size of two metals as they are subjected to a change in temperature. They are made of strips of two or more metals laminated into a multilayer piece. As the laminated metal strip is subjected to a change in temperature, its individual laminations expand or contract different amounts, causing the strip to bend or change curvature. The bimetallic element of an industrial thermometer is usually fabricated in the form of a helical coil with one end fixed and the other end free to turn as a result of differential expansion. The turntable end operates a pointer which rotates over a calibrated dial.

This thermometer has a similar, but not quite as broad, field of use as the liquid in glass thermometer. Its approximate limits of operation are from minus 300 to plus 1200 F (but not over 800 F for sustained operation). Its accuracy is about 1 per cent of scale range and its response reasonably good.




*Courtesy, Rochester Mfg. Co. Inc*

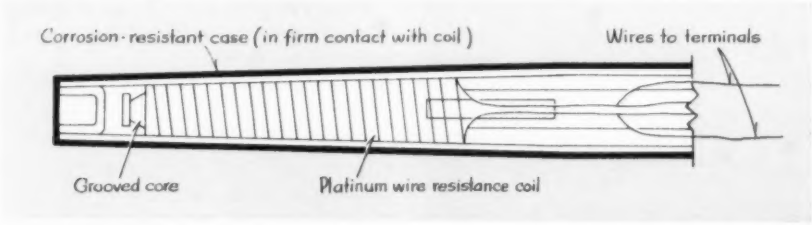
### Advantages

1. The bimetallic thermometer is relatively inexpensive.
2. It is much more rugged and less subject to damage than liquid in glass thermometers.
3. It is direct reading and requires no other equipment or outside power.

### Disadvantages

1. A bimetallic thermometer cannot be remote indicating.
2. It is not quite as accurate or sensitive as higher grades of liquid in glass thermometers.
3. It does not operate over as wide a total range as liquid in glass thermometers.
4. It cannot have as narrow a span as liquid in glass thermometers.

## RESISTANCE THERMOMETERS




*Courtesy, Leeds & Northrup Co.*

A resistance thermometer, as the name implies, measures temperature as a function of the change in electrical resistance of a wire as it is subjected to a change in temperature. This type is the most accurate of the three remote reading temperature measuring systems. The resistance thermometer is the standard for the International Temperature Scale in the range of minus 297 to plus 1167 F.

The resistance thermometer is made by winding a length of insulated wire, usually nickel, copper, or platinum, around a high-conductivity solid metal core. In use, the tip of the core is kept in contact with the bottom of its well so that heat is transferred rapidly to the resistance winding for high speed of response.

As the temperature of the winding increases, its resistance increases. The resistance is continuously and automatically measured by a modified Wheatstone Bridge type instrument. Output signals from the instrument operate a pen or pointer on a calibrated chart or scale to indicate the measured temperature. Resistance thermometers are normally used in the measurement range of minus 325 to plus 1000 F.

### Advantages

1. A resistance thermometer is highly accurate.
2. It has a high speed of response.
3. There is virtually no limit to the distance between the measurement point and the recording or indicating point.
4. Its response is linear over its range.
5. Measurement accuracy is not affected by ambient temperature changes.
6. Special lead wire is not required as for thermocouples.

### Disadvantages

1. The resistance element is relatively expensive when compared to a thermocouple.
2. The device requires a complex, expensive instrument to convert resistance change to a temperature indication or record, as compared to the instrumentation required for a filled system.
3. It is more subject to damage from over-ranging than is the thermocouple.
4. Its operating range is relatively narrow.

## THERMISTORS

Thermistors are a special type of resistance thermometer. They measure temperature as a function of electrical resistance, but have a much higher temperature coefficient of resistivity than resistance thermometers. They are therefore used for temperature measurements over a much lower scale range.

Thermistors are made of semiconductor materials (usually oxides of cobalt, copper, iron, magnesium, nickel, tin, titanium, uranium, and zinc) which are compacted into rod shapes from powders. The rods vary in diameter from 0.015 to 1 inch. They are used for special applications—in industry, medicine, research, and high altitude meteorological observations—where extreme accuracy, sensitivity, and fast response times, coupled with small size and light weight, are required.

## THERMOCOUPLES

Thermocouples measure temperature as a function of the voltage generated at the junction of wires of two dissimilar metals in close contact. The higher the temperature of the junction the greater the voltage generated. Thermocouples can measure higher temperatures than can be measured with filled systems or resistance thermometers, and may be used to measure temperatures as low as can be measured with resistance thermometers. However, thermocouples are not as accurate as resistance thermometers at low temperatures.

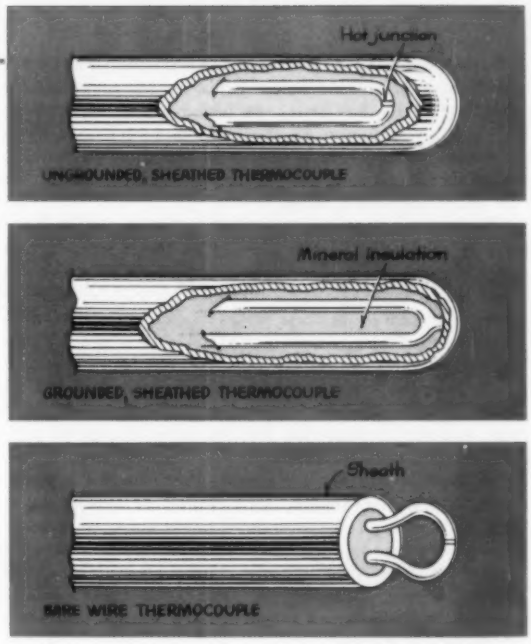
The four most commonly used thermocouples and their ranges of operation are:

1. Copper-constantan; minus 300 to plus 600 F.
2. Iron-constantan; zero to plus 1550 F (intermittent service to 1800 F).
3. Chromel-alumel; zero to 2000 F (intermittent service to 2300 F).
4. Platinum-platinum, 10 per cent rhodium; zero to 2800 F. This type of thermocouple is used as the standard for the International Temperature Scale from 1167 F (the freezing point of antimony) to 1945 F (the freezing point of gold), and is unequaled for accuracy in this range.

Special thermocouples have recently become available which are suitable for use at considerably higher temperatures than the common types. These thermocouples employ other materials such as iridium, rhenium, molybdenum, and tungsten. Some have been calibrated at temperatures up to 4000 F.

**Advantages**

1. The common type of thermocouple is relatively inexpensive (thermocouples for higher temperature measurement, being made of noble metals such as platinum, rhodium, and iridium can, however, be costly).
2. The thermocouple is accurate—relatively more so than other types of temperature measuring elements at elevated temperatures.
3. It has a high speed of response.
4. There is virtually no limit to the distance between the measurement point and the recording or indicating point.




*Courtesy, Conax Corp.*

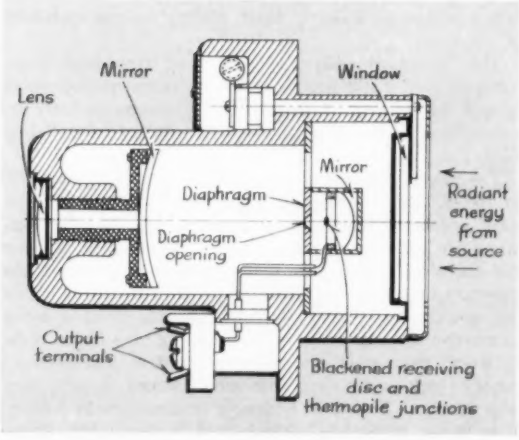
5. Its operating range is relatively wide.

**Disadvantages**

1. A cold reference junction is required, with compensation if the junction temperature can change.
2. It requires a relatively complex, expensive instrument to convert the generated voltage to a temperature indication or record, as compared to that required for a filled system.
3. Response of a thermocouple is not linear over its range (receivers can be calibrated to handle this).
4. Special lead wire is required.
5. It is subject to deterioration by corrosion, contamination, and metallurgical changes occurring as a result of normal usage.

# 2 INDIRECT TEMPERATURE MEASURING DEVICES

## RADIATION PYROMETERS




*Courtesy, Leeds & Northrup Co.*

Radiation pyrometers measure temperature as a function of the intensity of the radiation given off by a hot body. A radiation pyrometer system includes an optical system which focuses radiant energy from the source upon a blackened receiving disk. Attached to the disk are the measuring junctions of a thermopile (multiple thermocouples connected in series). The lead wires of the thermopile are connected to a temperature indicator or recorder similar to those used with thermocouples. The temperature of the disk rises in proportion to the intensity of the radiation focused upon it until the rate of its heat loss equals its rate of heat absorption from the source. Since the reference junctions of the thermopile are at the ambient temperature of the instrument housing, the difference in temperature between the hot and cold (measuring and reference) junctions produces a millivoltage output which is read on an indicator or recorder in terms of temperature of the source. Radiation pyrometers provide greater temperature sensitivity at the high ends of their ranges, mainly due to the fact that the intensity of hot body radiation is proportional to the fourth power of the absolute temperature of the body.

Since the amount of radiation received is dependent upon the distance of the instrument from the hot body and the emissivity of the hot body, the instrument is calibrated in the field by setting it to the temperature indicated by a thermocouple or optical pyrometer at one point on its scale. When set for one point the measurements will be correct over the entire instrument range.

The instrument reading is lowered by absorption of radiation by smoke and furnace gases in its line of sight. These gases may be invisible but possess absorption bands within the wave length range of the instrument. Therefore, when being used to measure temperature within a combustion or reaction chamber, the device is often focused upon the inside of a protecting tube which extends into the furnace. The tube reaches the temperature of the inside of the furnace but excludes the interfering smoke and gases. This expedient, however, imposes an additional time lag when fluctuating temperatures are being measured.

To improve accuracy and reproducibility for the measurement, and because ambient temperatures can vary considerably in the area of application of these instruments, automatic compensation is usually provided. This is accomplished by connecting a thermal conducting member, of the correct thermal coefficient and size, from the measuring junction to the reference junction. The thermal conductor, of course, is insulated from the electrical circuit. By this means, the heat flow pattern from measuring to reference junctions can be set to maintain constant output, and therefore constant temperature indication, despite varying housing temperatures. Because no external reference junction compensation is required, no special extension lead wires are required and ordinary insulated copper wires may be used.

The range of operation of radiation pyrometers is from 800 to 7000 F, and they may have spans of from 700 to 2000 F. Changes in the sighting lens opening, radiation focus of the instrument, location of the instrument (distance to the target), and changes in the electrical circuit are the means by which the span for a given instrument may be shifted over the range and widened or narrowed.

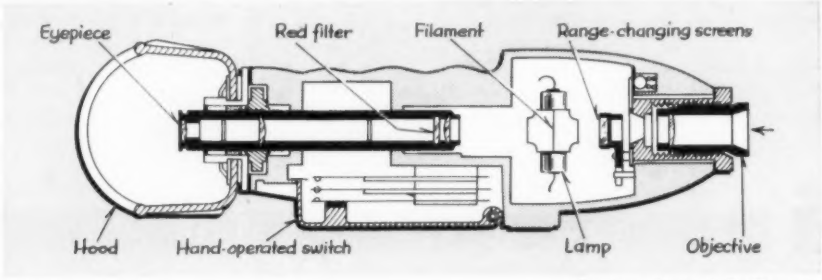
**Advantages**

1. The radiation pyrometer has one of the highest upper range limits (7000 F) of any standard means of measuring temperature.
2. It has a high speed of response.
3. There is no deterioration of the element by corrosion, contamination, or metallurgical changes occurring during operation because the instrument does not touch or come in contact with the material whose temperature it is measuring. Also, no special mounting arrangements are required.

**Disadvantages**

1. The instrument must be calibrated in place.
2. Furnace atmospheres interfere with its readings without the use of a protecting tube.
3. It is expensive compared with a thermocouple, which can also be used in the lower temperature ranges.
4. It must "see" the temperature it is measuring. This requires either an open hole, a hole with a transparent lens, or a protecting tube in the furnace or other equipment whose internal temperature is being measured.

## OPTICAL PYROMETERS




*Courtesy, Leeds & Northrup Co.*

Optical pyrometers measure temperature as a function of the brightness of the body whose temperature is being measured. Instruments of this type include a telescope and a potentiometer. The telescope contains a filament which is made to glow by regulating the flow of current through it. The telescope is focused upon the hot, glowing object whose temperature is being measured. The filament appears, in the telescope view field, to be superimposed upon the hot object. In measuring, the filament current is adjusted until its brightness just matches that of the hot object. Then a fine measurement is made of the filament current by balancing a galvanometer. This same adjustment positions a temperature scale to the temperature of the filament which, by being at the same brightness, is also at the same temperature as the hot object. This is true, of course, only if the hot object is emitting black body radiation. This would be the case if the object were completely surrounded by other objects all at the same temperature, as on the inside of a furnace which has reached equilibrium. Certain objects that are nonreflecting such as carbon, oxidized iron, steel, and nickel surfaces, are considered to be emitting black body radiation even when viewed in the open. When an optical pyrometer is being used to measure the temperature of reflecting, shiny objects it must be equipped with compensating screens to make it direct reading for the emissivity of the object.

The "disappearing-filament" method of temperature measurement, used in the optical pyrometer, is the method which is used for defining the International Temperature Scale between fixed calibrated points above the melting point of gold (1945 F).

The range of operation of optical pyrometers is from 1400 to 7600 F. For temperatures from 1400 to 2250 F, the filament and object are compared directly. For higher temperatures, an absorption screen is placed between the filament and the object. This reduces the apparent brightness of the object so that it can be observed by the eye, and is within the normal range of the filament brightness. With a screen in position the instrument is direct-reading on a higher scale.

Optical pyrometers are calibrated in the manufacturer's factory; high grade instruments are calibrated in accordance with National Bureau of Standards requirements as follows: Low Range ±7 F, High Range ±14 F, Extra High Range ±25 F.

The limit of error for a particular measurement cannot be stated because measurements are subject to sources of errors such as object emissivity, operator experience, smoke and fumes in the sighting path, and dirt in the optical system. However, experienced, competent operators and good maintenance can minimize these causes of error.

**Advantages**

1. The optical pyrometer has the highest upper range limit (7600 F) of any standard means of measuring temperature.
2. It is the most accurate means of measuring high temperatures.
3. It is calibrated in the factory and need not be calibrated in place.
4. It does not touch or come in contact with the material whose temperature is being measured.
5. Since it compares brightness, the distance from the material whose temperature is being measured is of no consequence so long as the material is large enough to provide an image in the telescope.

**Disadvantages**

1. The optical pyrometer cannot record or continuously indicate.
2. It requires manual operation and adjustment to provide a reading.
3. It is subject to human error because of the necessity of making a visual comparison of the brightness.
4. Object emissivity, and smoke or fumes in the sighting path, can cause considerable error in the reading.
5. It is expensive compared with thermocouples, which can also be used in the lower ranges.
6. It must "see" the temperature it is measuring. This requires either an open hole or a hole with a transparent lens in the wall of the furnace or other equipment whose internal temperature is being measured.

## 3 DISCRETE TEMPERATURE MEASURING DEVICES

### COLOR CHARTS AND INSTRUMENTS

The color of a hot body is a function of its temperature. Everyone concerned with the heat treating of metals is familiar with printed color charts used for rough determinations of an object's temperature. Some work has been done on instruments based upon temperature measurement by a change in color, but so far they have not found wide application.

### PYROMETRIC CONES

Pyrometric cones indicate temperature by a change of state. That is, they melt. A set of cones is used, each one formulated of a composition having a slightly higher melting point than the one before it. A set of 60 cones can represent equal temperature increments between 1085 and 3660 F. As the temperature rises, the cones soften and bend in sequence. They can be used to indicate only rising temperatures, and are used in kiln operations and for other noncritical temperature measurements. A new set must be used for each sequential reading.

### SURFACE APPLIED TEMPERATURE SENSITIVE MATERIALS

These are temperature sensitive materials of a chemical nature that are applied directly on surfaces where temperatures are to be measured. They are usually in the form of a chalk-like crayon or a paint-like liquid. Small pellets are also available. When applied, these materials are in close contact with the heated surface. Their films are very thin so that they attain the temperature of the surface almost instantaneously by conduction.

Temperature sensitive materials do not provide continuous temperature indication or recording, and must be watched continuously to determine when a rising temperature reaches their indicating points. The most widely used commercial temperature sensitive materials indicate temperature by liquefying, although temperature can also be indicated by a change in color. They are available to melt at temperatures from 113 to 2500 F in 12 to 50 degree steps.

**CORRECTION**

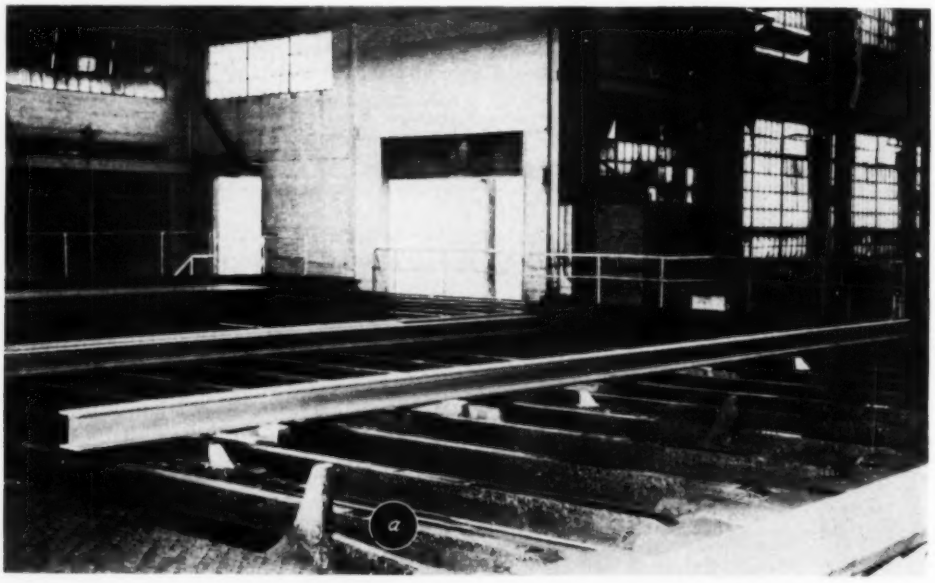
In the article entitled "Role of Computers in Automation" which appeared in the March 1960 issue an error of address appears in the listing on page 57. The Electronics Div. Monroe Calculating Co. address should read: "Orange, N. J."

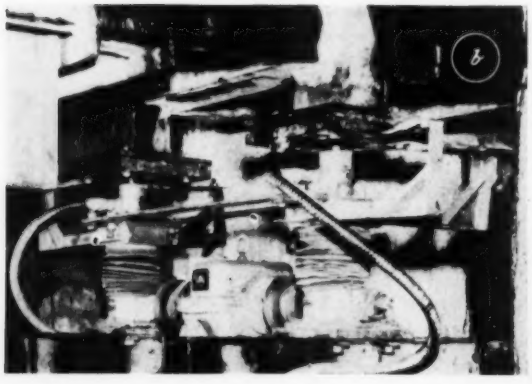
# FAST WEIGHING INCREASES I-BEAM ACCURACY

ONE CHECK made on I-beams after they are rolled is to determine their weight per unit length. If the cross section is too light the beam might not meet the customers' specifications. If it is too heavy, steel is wasted. A method formerly used to check weights in one mill was to cut a sample from the beam and weigh it on a mechanical scale. Even if that test indicated the beam was off-weight, several more beams could be rolled incorrectly during the time required to check the weight.

That mill has now installed an electronic weighing system to weigh whole I-beams generally 40 feet long and ranging in weight from 10 to 67 pounds per foot (400 to 2700 pounds per beam). After rolling, the I-beams are sawed into lengths and moved onto a hot bed (*a*) to cool. Eight support rails can be raised between the rails of the hot bed to lift the beam. These rails are supported by a platform resting on four load cells supplied by Baldwin-Lima-Hamilton Corp. Each end of the platform and its supporting load cells are raised and lowered by two mechanical screw jacks (*b*).

I-beams are rapidly weighed under control from a console (*c*). Weight is indicated on a dial and simultaneously printed on a card inserted by the operator. Instructions can be flashed instantly to the roller if the beam is outside the two per cent tolerance allowed.



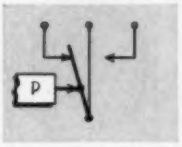
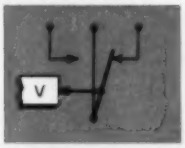
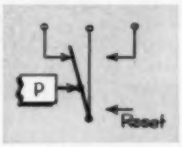
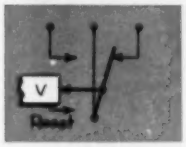
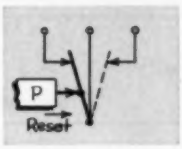
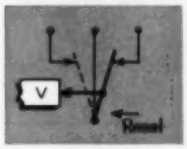
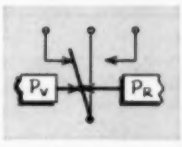
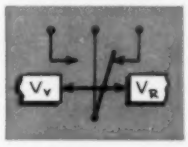
| Pressure Actuated | PRESSURE SWITCH CONTACTS | | Vacuum Actuated |
|---|---|---|---|
| AUTOMATIC RESETTING — single pole, double throw switch can actuate either on increasing or decreasing pressure. |   |   | AUTOMATIC RESETTING — single pole, double throw switch can actuate as vacuum approaches absolute zero or as vacuum decreases to atmospheric pressure. |
| MANUAL RESET—actuates on increasing pressure. Must be manually reset when pressure decreases. |   |   | MANUAL RESET—actuates on increasing vacuum. Must be manually reset when vacuum decreases. |
| MANUAL RESET—actuates on decreasing pressure. Must be manually reset when pressure increases. |   |   | MANUAL RESET—actuates on decreasing vacuum. Must be manually reset when vacuum increases. |
| DIFFERENTIAL PRESSURE — actuates when there is a preset difference between the reference pressure, $P_R$, and the variable pressure, $P_V$. |   |   | DIFFERENTIAL VACUUM — actuates when there is a preset difference between the reference vacuum, $V_R$, and the variable vacuum, $V_V$. |

Fig. 1—Pressure sensing mechanisms shown in TABLE 1 can be used to actuate these configurations of switch contacts. The switches are shown in normal positions with pressure ports open to atmosphere. Pressure actuated switches are normally used with diaphragm, Bourdon tube, or piston sensors. Vacuum actuated switches are usually employed only with diaphragm sensors.

# USING PRESSURE SWITCHES

## TO MONITOR AND CONTROL

**In many applications, pressure switches can be used in fluid pressure systems to provide an adequate and effective means for controlling equipment, monitoring for component malfunctions, and warning of unsafe operating conditions. The author discusses the various types of pressure switches, their limitations, and typical methods of application.**

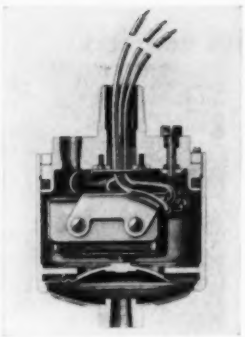
By **JAMES O. BROWN**, Manager, Eastern Division, Barksdale Valves, Los Angeles, Calif.

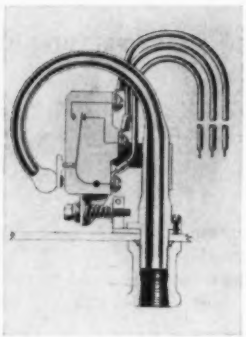
PRESSURE is available as a controlling variable in a great number of industrial processes. While pressure sensing and control systems encompass a variety of techniques, the simple pressure switch is probably one of the most foolproof and reliable devices to use as a pressure sensing element. The only limit to its versatility seems to be the ingenuity and imagination of the system designers.

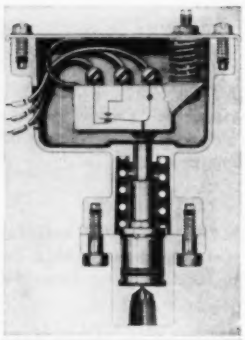
It is somewhat paradoxical that the very simplicity and dependability of pressure switches have combined to provide them with an aura of commonplaceness and a lack of glamour. This conception has served to limit their use in applications where they could be of the greatest benefits. Many engineers have a tendency to apply complex and expensive mechanisms to protect and/or control equipment and processes. In many cases, the complex

**TABLE 1**

**Basic Types of Pressure Switches**







| | Diaphragm | Bourdon Tube | Piston |
|---|---|---|---|
| Operating Pressure | | | |
| Minimum | 30-inches Hg vacuum | 15 psi | 35 psi |
| Maximum | 100 psi | 8000 psi | 12,000 psi |
| Proof Pressure, maximum | 150 psi | 12,000 psi | 20,000 psi |
| Expected Life, cycles | | | |
| Full Pressure Range | 750,000 | 750,000 | 6 million* |
| Half Pressure Range | 2 million | 2 million | — |
| 10-20% of Full Pressure | 4 million | 4 million | — |
| Sensitivity** | 0.3-inches $H_2O$ | 5 psi | 10 psi |

*1. Piston type switches should be serviced every 6 million cycles or each year, whichever occurs sooner.
**2. Minimum pressure differential required to actuate switch.

mechanisms do not perform any more satisfactorily than would a simple pressure switch with an average price of less than $50. The pressure switch is not only far less expensive in first cost, but, as a direct result of its greater simplicity, is lower on maintenance costs.

The three general fields of application for pressure sensing by switch are process control, monitoring, and safety. However, there is often an overlapping of applications between all three of these fields. Many different ways are available for applying pressure switches to improve safety conditions or to simplify operations. The results obtainable are, however, contingent upon the type of pressure switch used and the method of its application. The pressure to be sensed, the over-all pressure range, the sensitivity required, and the location of the switch all help to determine the best switch and method of application.

The three types of pressure sensing mechanisms ordinarily used are the diaphragm, Bourdon tube, and piston. A comparison of the general characteristics of these three types is shown in TABLE 1. Each of these sensing mechanisms can actuate various configurations of electrical switches as shown in *Fig.* 1.

## ▶ Limitations

The pressure switch sensitivities shown in TABLE 1 are the maximum which can ordinarily be obtained with particular types of pressure sensing elements. These sensitivities can only be achieved under optimum conditions. A requirement necessitating the use of a higher capacity switch—in place of using a relay—or the use of long sensing lines will reduce the sensitivity obtainable. For optimum sensitivity and response time the switch should be placed as close as possible to the pressure source and should carry a minimum electrical load.

The type of pressure switch will be indicated by the operating pressure and the desired sensitivity. In some cases, however, the cyclic life requirement may take precedence over the sensitivity. If the switch is to be subjected to continuous cycling, either a piston type or a switch with a higher pressure

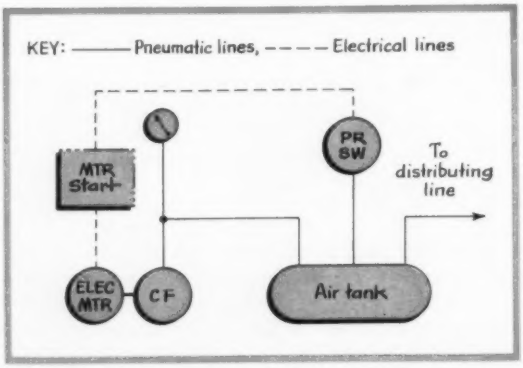



**Fig. 2—Pressure switch in an air compressor system starts the drive motor when the pressure in the air tank drops below 125 psi. When pressure rises above 150 psi, the switch stops the compressor.**

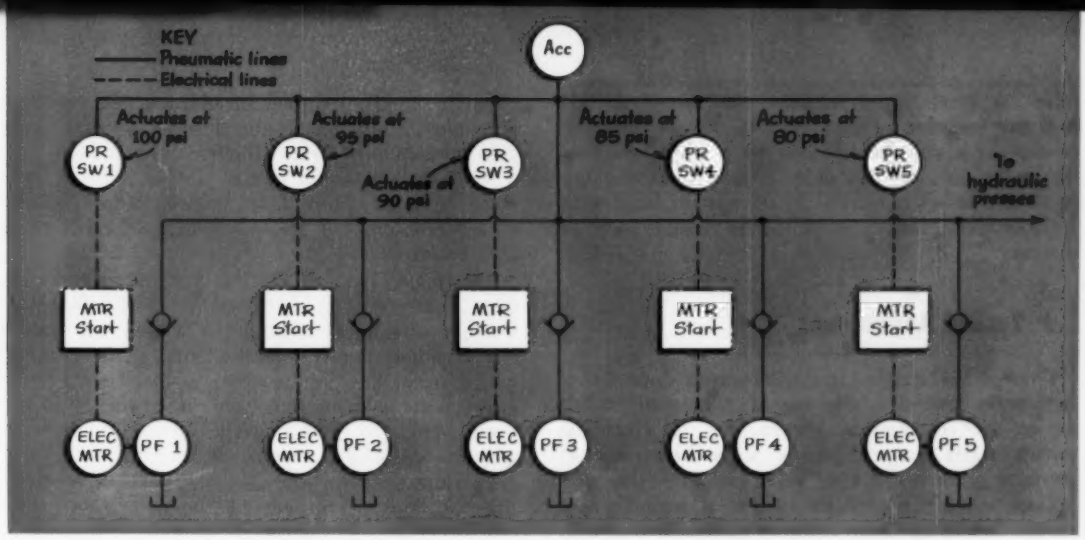



Fig. 3—In this system for maintaining hydraulic pressure in a central accumulator, up to five motor-pumps can supply oil under varying load conditions. Pump *PF1* is started by pressure switch *PRSW1* when the hydraulic pressure drops below 100 psi. If the pressure continues to drop, pressure switch *PRSW2* actuates pump *PF2* when the pressure drops below 95 psi. Additional pumps are connected into the system for each 5 psi drop in pressure. The system pressure seldom drops to a point where all five pumps are required at the same time.

rating (with consequent reduction in sensitivity) must be used in order to obtain a desired life cycle.

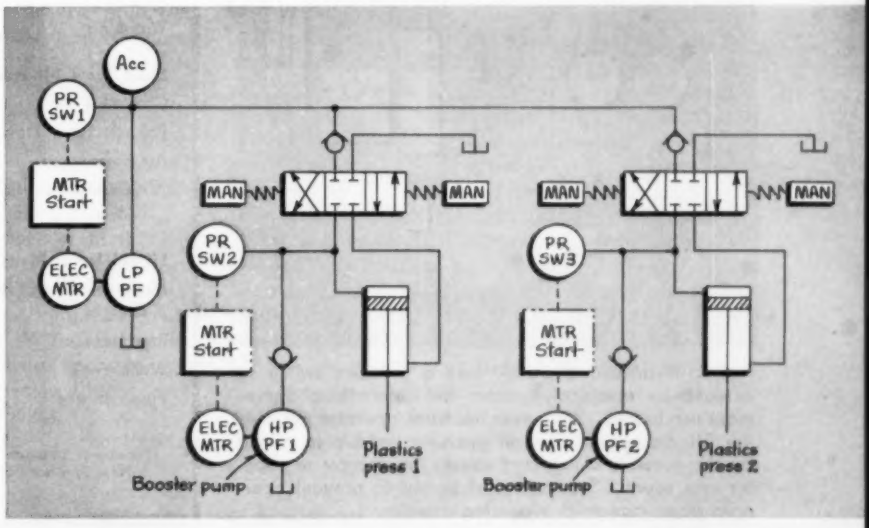
Pressure switch life, response time, and sensitivity can be markedly affected by the method of application. In fact, the installation is as important as the selection. For best results and most economical installation, a pressure switch should be selected for its relative insensitivity to vibration and for its ability to operate in any mounting position.

A long sensing line will act as a surge damper and will reduce the switch sensitivity to the point where it may even fail to sense pressure surges of short duration. If response to short peaks is important, sensing line length should be held to an absolute minimum.

Temperature extremes and corrosive fluids can cause considerable difficulty in the operation of pressure switches. With fluids operating at extreme temperatures, either hot or cold, the installation should include an isolating line or a "pigtail" between the pressure source and the pressure switch. A relatively short length of small diameter tubing will serve to keep the pressure switch at essentially ambient temperature and still provide only a very small surge chamber. An excess length of large tubing will act only as a surge damper.

The deleterious action of corrosive liquids can be obviated through the use of a small chamber filled

Fig. 4—Oil is supplied to the main cylinders of these plastics presses by two separate supply systems. A low pressure system supplies high volume oil to the presses from a central accumulator. When the operator manually actuates the valve to Press 1, oil enters the cylinder from the low pressure system until pressure switch *PRSW2* senses the maximum low pressure. At this point, high pressure pump *PF1* is actuated and raises the cylinder pressure to a much higher pressure. Operation of Press 2 is similar except that high pressure is applied through pressure switch *PRSW3* and pump *PF2*.



with an inert liquid between the corrosive fluid and the pressure switch. This liquid may best be located in a chamber divided by a corrosion-proof diaphragm, or, in some cases, it may be satisfactory to merely insert a U-tube in the system filled with a heavy and non-miscible buffer liquid such as mercury.

## Typical Applications

One of the simplest and commonest examples of automatic control is the use of a pressure switch in an air compression system, *Fig.* 2. Here the switch starts the compressor when the reservoir pressure drops below a set value and stops the compressor when the pressure rises to a second preset value. A slightly more complex system is one used to maintain liquid pressure in a large central accumulator which supplies a battery of hydraulic presses in a plastics plant. With peak operation of all presses, a bank of five motor-pumps is required to maintain accumulator pressure, *Fig.* 3. In general, line pressure seldom falls to a level requiring simultaneous operation of all pumps. In this plastics plant installation, one motor-pump is set to start when the accumulator pressure drops below 100 psi. A second motor-pump is started in parallel with the first unit when pressure drops below 95 psi. If the pressure continues to drop, additional motor-pumps are added to the system for each 5 psi drop in pressure.

This arrangement provides greatly extended pump life since the number of stops and starts of all the pumps is greatly reduced. In addition, the sequence of pump operation is changed each month to provide more uniform wear of the five units.

Another installation in the plastics industry provides automatic control of main cylinder pressure on a plastic press. A pressure switch is used to sense this pressure, *Fig.* 4.

The major part of the liquid is supplied to the press from an accumulator system. When the cylinder pressure reaches a preset value, a pressure switch automatically starts a small booster pump which raises the ram pressure to the desired value and maintains it at that point until the cycle has been completed. Other cyclic hydraulic processes may be controlled in a similar fashion.

Pressure switches are also adaptable to monitoring functions as an aid in the determination of

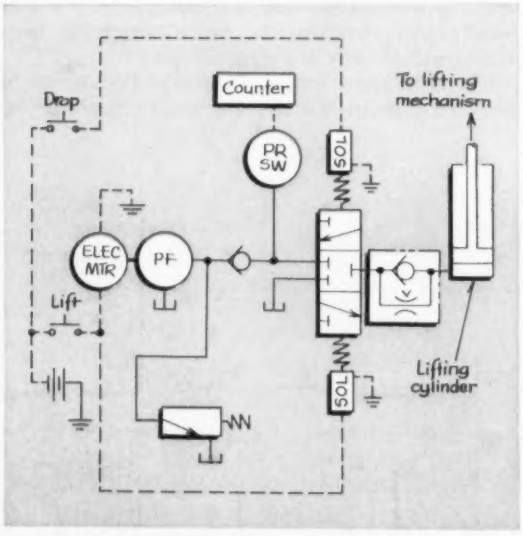
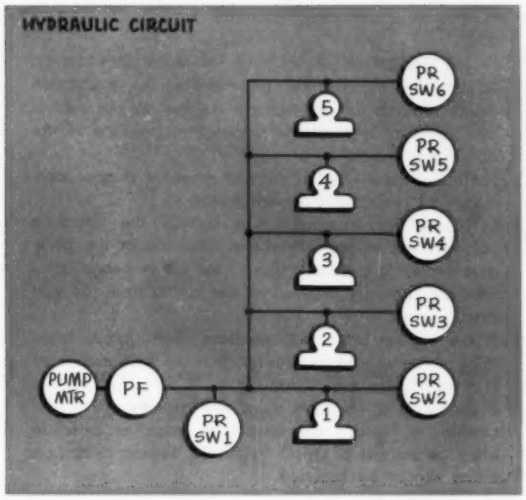



**Fig. 5—Hydraulic lift truck uses a pressure switch to actuate an electrical counter for determining equipment use factor. Whenever the truck operator actuates the lift mechanism, the oil pressure buildup is sensed by the pressure switch and causes the counter to register one count. System was designed to prevent operator from manually triggering counter.**

**TABLE 2—Typical Applications for Pressure Switches**

| Application | Function Sensed by Switch |
|---|---|
| **Direct Pressure Measurement** | |
| Compressor | Overpressure and underpressure. |
| Hydraulic Lift | Overpressure to prevent overload. |
| Pump and Accumulator | Overpressure and underpressure. |
| Clamping Device | Low pressure or high pressure in air vise, air chuck, or vacuum chuck. |
| Hydraulic Steering | Low pressure. |
| Oil Burner | Inadequate air supply pressure. |
| Gas Burner | Inadequate gas supply pressure. |
| Filter | Upstream pressure to warn of plugged filter. |
| Boiler | Water pressure to feed pump. Sense boiler overpressure or pressure too low to operate equipment. |
| Process Equipment | Pressures in ovens, vacuum chambers, and molds. |
| Fluid Transmission Lines | Low pressure to indicate line break. |
| Gas Filled Cables | Low pressure indicating leak or break. |
| Weighing | Pressure in hydraulic load cell. |
| **Fluid Flow Measurement*** | |
| Coolant Flow | Low flow. |
| Process Fluid Flow | Correct rate for process. |
| Air Flow | Flow for heating or drying. |
| Air Conditioning Flow | Low flow to ensure adequate ventilation through all branches. |
| **Liquid Level Measurement**** | |
| Machine Tools and Engines | Lubricant level. |
| Storage Tank | Liquid level. |
| Wash Tank | Water level. |
| Pump Intake | Liquid level to prevent dry pumping or cavitation. |

*Sensing of pressure drop across an orifice.
**Sensing of pressure due to liquid head.



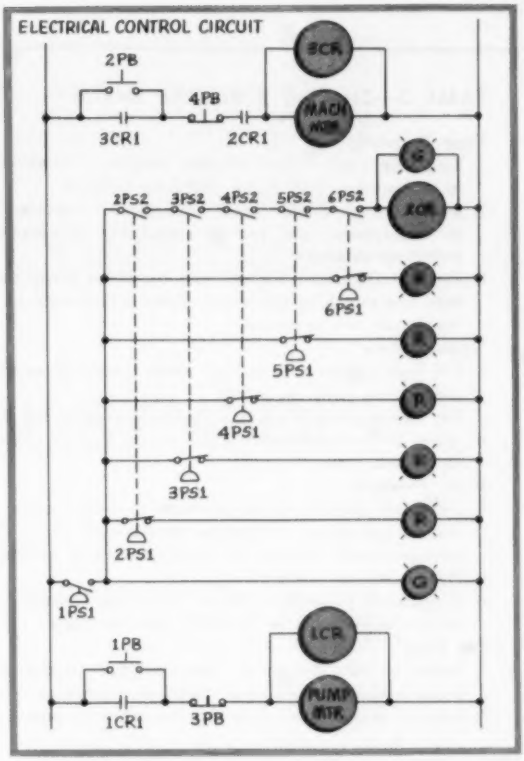




**Fig. 6—Pressure switches can monitor the pressure of lubricant being pumped to multiple bearings. Operator starts lubrication pump by pressing pushbutton *1PB*. As pressure in lubrication distribution line builds up, pressure switch *PRSW1* is actuated and closes contact *1PS1*, illuminating a green lamp. As the lubricant reaches each bearing branch line and builds up pressure, pressure switches *PRSW2* through *PRSW6* are actuated, opening contacts *2PS1*, *3PS1*, *4PS1*, *5PS1*, and *6PS1* and closing contacts *2PS2*, *3PS2*, *4PS2*, *5PS2*, and *6PS2*. If all bearings are being properly supplied with lubricant, a second green lamp illuminates, informing operator that relay *2CR* has been energized and relay contact *2CR1* has closed. With lubrication system functioning properly, operator can start machine by pressing pushbutton *2PB*. For example if oil pressure drops at bearing 4 due to malfunction, pressure switch *PRSW5* is actuated. This action opens contact *5PS2*, stopping machine motor, and closes *5PS1*, illuminating red trouble light and identifying location of trouble.**

equipment use factors. Typical is the example of evaluating use factors of a fleet of hydraulic lift trucks in a warehouse to determine the optimum number which should be used. Mechanical counters, because they were easily hand actuated, were often manually triggered by lift truck operators to give false use records. These counters were replaced with electrical counters which were actuated by pressure switches, *Fig.* 5. The switches are actuated each time hydraulic pressure is applied to the lifting cylinder.

A technique for centralized production monitoring by pressure switches was installed in a plastics plant. Each hydraulic press was equipped with a pressure switch which operated a signal light on a panel in a supervisor's office. Without leaving his desk, the supervisor could keep track of the operation of all presses and immediately spot bottlenecks, breakdowns, or work stoppages.

Another relatively common type of monitoring application coupled with some control is in conjunction with pressurized lubrication systems. In mechanized plants, the trend is more and more toward automatic and continuous high speed operation. This, in turn, means that the old system of periodic hand oiling of bearings must be replaced by a modern automatic or continuously pressurized centralized lubrication system. Like any complex system, an extensive lubrication setup may develop a malfunction, and one of the many bearings will occasionally be skipped. Burnout of any one bearing will shut down the entire machine, so a continuous watch over each bearing must be maintained. This is prohibitively expensive and many times impossible to do manually but is easily and economically handled with pressure switches.

In such an application, pressure switches are installed so that, when the lubrication pressure to any bearing drops, its related pressure switch opens a circuit, *Fig.* 6, which shuts down the machine. Manually pinpointing one troublesome bearing is a difficult and time consuming task. Therefore, each switch also operates a trouble light on a master panel to identify the failing bearing immediately.

Another application of pressure switches in lubrication systems is on commercial fishing boat engines. Fishing boats may troll for hours, and any malfunction of the oiling system could cause burnout of a bearing. Breakdown of the engine in a boat at sea is extremely hazardous. This same type of automatic lubrication system pressure control is applicable to stationary or mobile internal combustion powerplants such as electric generating plants, pumping plants, trucks, etc.

Pressure switches are often used as safety devices with air chucks to shut down a lathe or other

**TABLE 3—Selecting a Pressure Switch**

**Type Required**

1. Single Setting—single contained pressure, referenced to atmosphere, and single switching element.
2. Dual Setting—single contained pressure, referenced to atmosphere, and two independently adjustable switching elements.
3. Pressure Difference Switch—two contained pressures with one switching element to sense a difference between the two pressures.

**Cycling Rate**

1. For high cycling rate or high surge pressures, select piston type pressure switch.
2. For extreme sensitivity and cycling rates under 30 cycles per minute, select a diaphragm or a Bourdon or bellows pressure switch.

**Proof Pressure**

1. Determine the maximum pressure to which system will be subjected, including surge pressure. Select a pressure switch for which proof pressure is greater than maximum pressure.
2. If maximum pressure is greater than proof pressure, a surge damper or gage protector must be used.

**Set Point**

1. Determine actuation point (set point) and whether it is reached by increasing or decreasing pressure.
2. Select a pressure switch so that the actuation point is in the middle 40 per cent of the adjustable range. A set point close to the high end of the adjustable range reduces the life factor. The first 10 per cent of the range is less accurate than the balance of the adjustable range.

**Actuation Value**—the amount of pressure change necessary to reset the pressure switch.

1. In 80 per cent of normal applications, the actuation value is not critical since the actuation of the pressure switch is a final action. Once the switch is actuated momentarily, it is out of the circuit until the unit starts again.
2. If the system has small pressure fluctuations, actuation value should be greater than the fluctuations so that system does not flutter.
3. If switch is to be used on a system where it is desirable to "clear" the circuit as soon as possible after actuation, a switch with the lowest actuation value should be selected.

**Electrical Rating**

1. A pressure switch differs from a pressure gage, in that a pressure switch has to do more work than a gage. The higher the electrical demands upon a pressure switch, the more energy it must deliver, thus reducing its accuracy and life. For optimum performance, keep electrical requirements to a minimum. For high electrical loads, use a relay in conjunction with the switch.

machine tool in case the air pressure to the chuck lowers to a dangerous level. They also can be used with vacuum chucks for control when the pressure rises. Pressure switches in such installations have actually saved lives. Unfortunately, their lack of use has occasionally cost a life when a sudden excessive demand upon the shop air supply lowered the pressure enough to permit the chuck to become "spongy" and throw out the workpiece.

There are, of course, many other applications where a pressure switch can serve as a warning for impending danger to equipment and/or personnel. Some of these have been tabulated in TABLE 2, along with other control and monitoring applications.

This has been a brief review of some of the commoner uses of pressure switches and a few of the more unusual applications. Depending upon requirements, a pressure switch will frequently give satisfactory results more dependably, and far more economically, than a complex control system. Requirements should be carefully analyzed and itemized before any control or monitoring system is installed. It is quite possible that a few pressure switches and a bit of ingenuity may save money and reduce maintenance problems.

**are you stuck?**

Since its inception AUTOMATION has helped increasingly in the solutions of hundreds of widely diversified practical problems in making manufacturing operations more automatic. Regardless of the character of the operation or system being developed, somewhere in industry a similar problem has been solved and, very often, equipment is available from reliable builders or suitable techniques are known to specialists.

Development can be simplified, engineering costs reduced, and reliability guaranteed with tried and proved equipment and devices available today for achieving successful automation. Whether the problem is simple or complex, practical or technical, if you have not as yet seen the answer to your need in the pages of AUTOMATION the Editors will be pleased to make special effort to help find the right answer. The vast reservoir of industrial know-how is yours for the asking. Take advantage of this reader service. Write to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio

**Applications of static switching control devices in industry are increasing. Unfortunately, the number of conventions to represent these devices on diagrams have also increased. To provide a standardized means of representing such control devices, the National Electrical Manufacturers Association has adopted a Suggested Standard for Future Design. AUTOMATION presents in this data sheet information from that standard which is contained as Part 15 in Section II of NEMA Publication No. IC 1-1959.**

# STATIC CONTROL SYMBOLS

WHEN two or more people wish to communicate with each other by means of symbols, they need a common understanding of the symbols to be used. The National Electrical Manufacturers Association meets this need by adopting standards designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper electrical product for his particular need.

Though a NEMA standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard, it does offer a means to define a product, process, or procedure by a recognized usage.

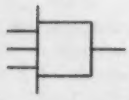
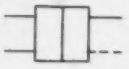
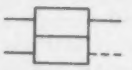
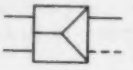
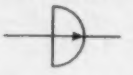
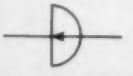
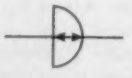
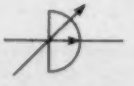
The particular standard adopted by NEMA for static switching control devices is a suggested standard for future design. This is a class of standard which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development. The following provisions are based on those found in NEMA Publication No. IC 1-1959.

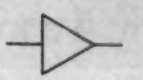
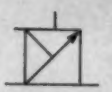
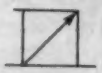
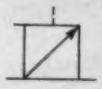
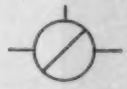
## General

Static switching control is defined as a method of switching electrical circuits without the use of contacts (the control primarily includes magnetic amplifiers and solid-state devices). Static switching control performs similar to the conventional use of relays except without switching contacts. Relays convert a single input to a coil into various outputs by means of its moving armature closing or opening contacts. Static switching control elements convert a single or combination of inputs into outputs by controlling the circuit's impedance and/or modulation. The logic terminology associated with static switching control is included herein to illustrate some operating logic functions. The same type of device may perform different control functions in the same equipment depending upon the required functions.

## Logic Functions, Symbols, and Definitions

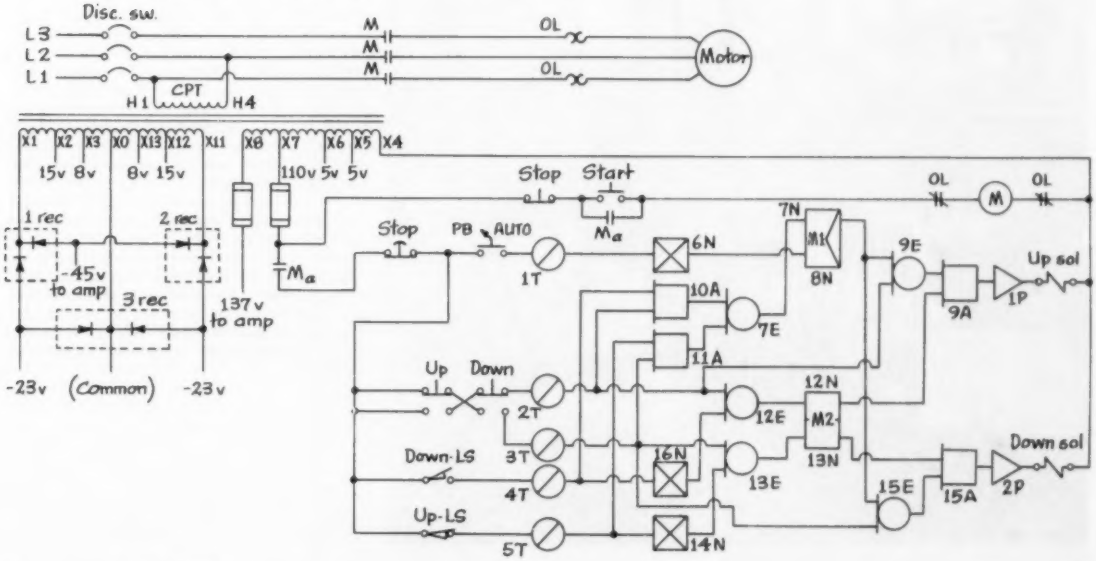
Device logic functions and symbols are illustrated and defined by the following. They are intended for use on electrical elementary or schematic diagrams to indicate the operating functions. The symbols are a shorthand graphical representation and not necessarily intended to represent the physical likeness of the device nor certain complete electrical connections. The symbols may be combined into various circuit adaptations as required by the particular application. NOTES: The term "input" or "output" denotes a signal which is useful or significant to elements of the system. The terms "on" and "off" denote the presence or absence of an output, respectively. The "off" condition does not necessarily mean that there is no signal. Input terminals are shown on the left side of symbols, and output terminals are shown on the right side of symbols.

| LOGIC FUNCTIONS | SYMBOLS | DEFINITIONS |
|---|---|---|
| AND |  | A device which produces an output only when every input is energized. The number of input terminals to the symbol may vary. |
| NOT | | A device which produces an output only when the input is not energized. |
| OR | | A device which produces an output when one input (or more) is energized. The number of input terminals to the symbol may vary. |
| MEMORY |  | A device which retains the condition of output corresponding to the input last energized, as long as power is maintained. The memory input and output *On* terminals are the upper lines on the symbol. The *Off* input terminals (and output terminals, when required) are the lower lines. |
| RETENTIVE MEMORY |  | A device which retains the condition of output corresponding to the input last energized. The memory input and output *On* terminals are the upper lines on the symbol. The *Off* input terminals (and output terminals, when required) are the lower lines. |
| OFF RETURN MEMORY |  | A device which retains the condition of output corresponding to the input last energized, except upon interruption of power it returns to the off condition. The memory input and output *On* terminals are the upper lines on the symbol. The *Off* input terminals (and output terminals, when required) are the lower lines. |
| TIME DELAY ENERGIZING |  | A device which produces an output following definite intentional time delay after its input is energized. |
| TIME DELAY DE-ENERGIZING |  | A device whose output is de-energized following a definite intentional time delay after its input is de-energized. |
| TIME DELAY ENERGIZING AND DE-ENERGIZING |  | A device which produces an output following a definite intentional time delay after its input is energized and whose output is de-energized following a definite intentional time delay after its input is de-energized. |
| ADJUSTABLE TIME DELAY ENERGIZING |  | A device which produces an output following an adjustable intentional time delay after its input is energized. |
| ADJUSTABLE TIME DELAY DE-ENERGIZING | | A device whose output is de-energized following an adjustable intentional time delay after its input is de-energized. |
| ADJUSTABLE TIME DELAY ENERGIZING AND DE-ENERGIZING | | A device which produces an output following an adjustable intentional time delay after its input is energized and whose output is de-energized following an adjustable intentional time delay after its input is de-energized. |

| LOGIC FUNCTIONS | SYMBOLS | DEFINITIONS |
|---|---|---|
| **AMPLIFIER** |  | A device in which an input signal controls a local source of power to produce an output enlarged relative to the input. |
| **GATE (Nonisolated)** | | A device which permits current flow in a nonisolated circuit when the control input is energized. The control input is the top left terminal. The power circuit terminals are the right and lower left terminals. Return circuit terminals are not shown when directly connected to common or ground. |
| **GATE (Nonisolated with return Circuit)** |  | A device which permits current flow in a nonisolated circuit when the control input is energized. Return circuit terminals are not shown when directly connected to common or ground. When return circuits need to be shown, the control circuit shall be connected as a top vertical terminal. |
| **GATE (Isolated)** |  | A device which permits current flow in an isolated circuit when the control input is energized. The control input is the top left terminal. The power circuit terminals are the right and lower left terminals. Return circuit terminals are not shown when directly connected to common or ground. |
| **GATE (Isolated with return Circuit)** |  | A device which permits current flow in an isolated circuit when the control input is energized. Return circuit terminals are not shown when directly connected to common or ground. When return circuits need to be shown, the control circuit shall be connected as a top vertical terminal. |
| **SIGNAL CONVERTER** | | A device for changing a pilot signal to a logic input. Return circuit terminals are not shown when directly connected to common or ground. |
| **SIGNAL CONVERTER (with return Circuit)** |  | A device for changing a pilot signal to a logic input. Return circuit terminals are not shown when directly connected to common or ground. When return circuits need to be shown, the control circuit shall be connected as a top vertical terminal. |

### Sample Logic Diagram

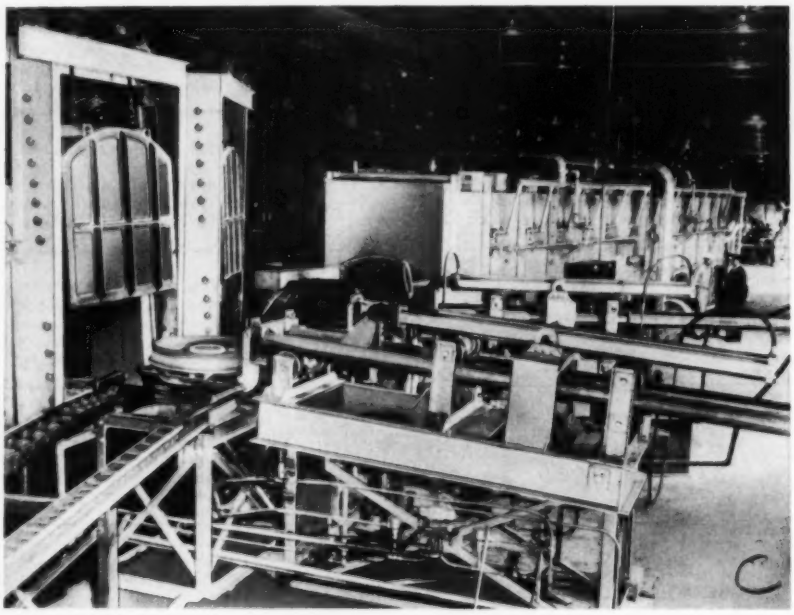
Sequence is from left to right: Inputs to logic elements are shown on left side and outputs on the right side. "On" input and output for memory are the upper lines, and "off" input and output are the lower lines. Single line diagram is used and return circuits are omitted. Power supply is shown at the top.

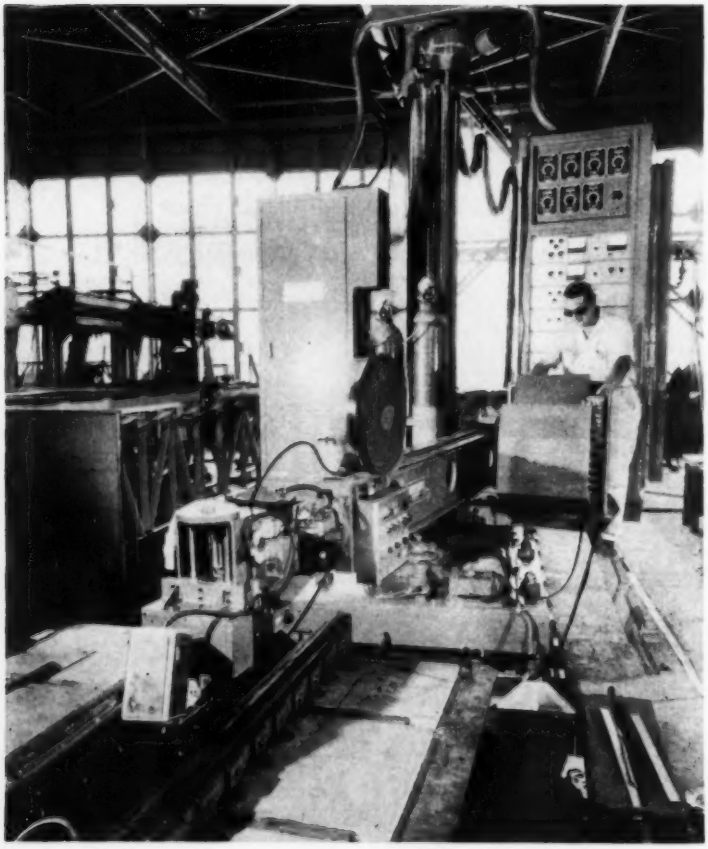


# automation in action

## Heat Treating Wheels

HEAT TREATING time for railroad car wheels has been decreased by the installation of a preheat furnace immediately prior to a rotary hearth heat treating furnace at the Colton, Calif., plant of Griffin Wheel Co. In the process, car wheels are automatically conveyed into the preheat furnace at the right of the picture and are quickly brought to desired temperature. The wheels are then conveyed to the rotary hearth furnace at the left of picture where they are automatically loaded and unloaded. Both furnaces were built by the Industrial Div., Lindberg Engineering Co.

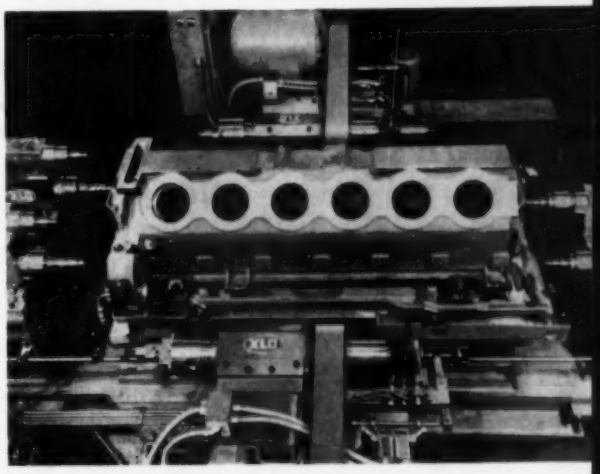




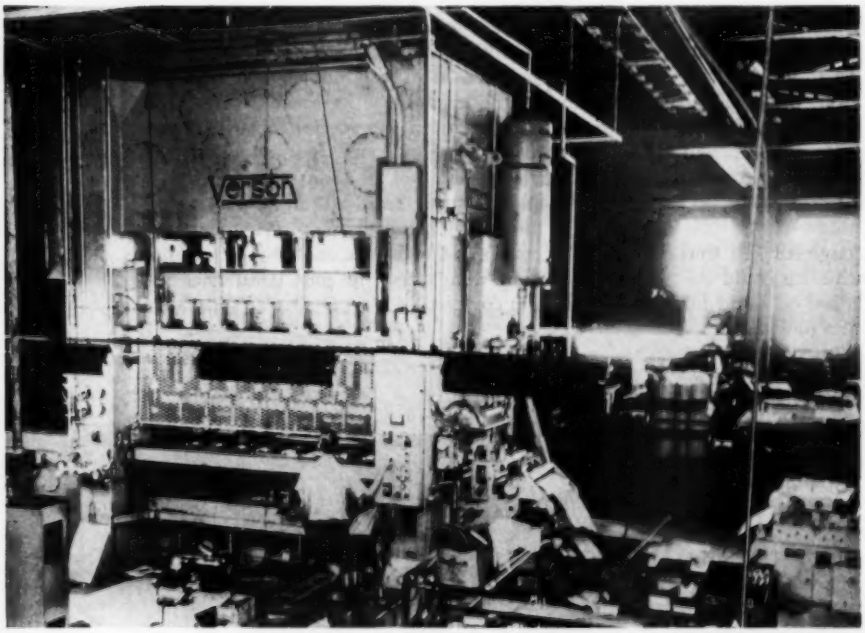
## Welding Aircraft Parts

AUTOMATIC boom manipulator-type fusion welder built by Sciaky Bros. Inc. is one of two custom-built units installed at North American Aviation Inc. to weld high-heat resistant, heat-treatable alloys in the B-70 bomber program. Movements include in-and-out weld motions of the main boom, 360-degree torch rotation, and fine horizontal or vertical head adjustments on the torch face plate. The boom can rotate in a full circle around the main column, move up and down the column from 3 feet above floor level to 10 feet, and extend to make an effective weld length of 12 feet. Movements of the machine are pushbutton controlled from the control station where an operator observes the weld in progress by means of a television monitor. A seam tracking system maintains alignment of the torch directly over the seam being welded and is capable of sensing a butt joint and tracing the seam as the head moves. The torch is kept at proper spacing in relation to the workpiece by a proximity transducer arrangement.

## Machining Crankcases



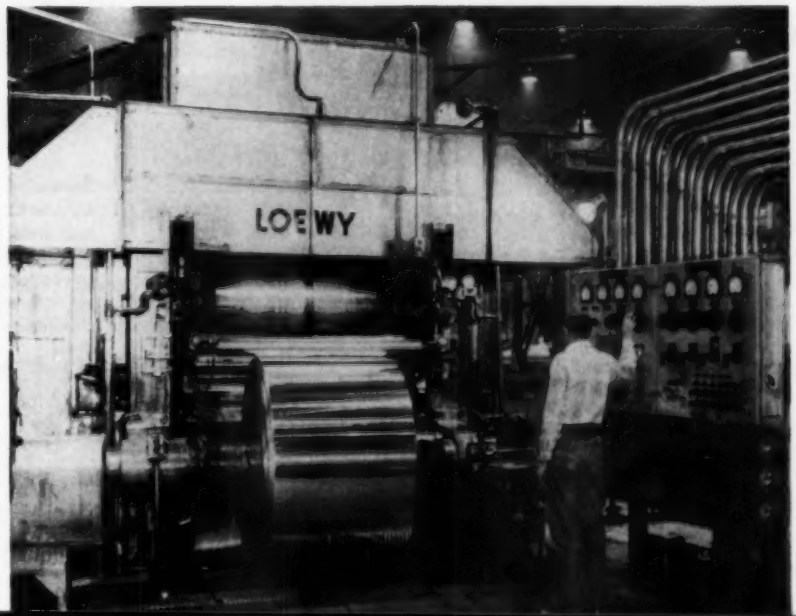
ALUMINUM alloy V-12 engine crankcases are automatically machined in this custom-built boring machine developed by Ex-Cell-O Corp. The machine was constructed from standard machine slides and other building block components, including eight precision boring spindles. The crankcase is manually clamped on a fixture table which is carried on a standard hydraulic slide. Two cross slides are used to feed boring and facing heads on each side of the workpiece, and, at the start of the machining cycle, these slides move into cutting position. As the fixture table slide is fed to the right, the tools on the two cross slides perform cutting operations on each side of the crankcase. During this time, the crankcase is also being fed into two spindles on the right end of the machine where two dowel holes are bored and chamfered. The main slide then reverses direction and feeds toward the four spindles mounted on the left end of the machine. After boring and chamfering operations are completed by these spindles, the two cross slides retract, and the fixture table again reverses and returns to its start position.




## Forming Speedometer Housings

SPEEDOMETER housings are formed from coil stock at a rate of 1200 per hour in this 300-ton capacity press installed at Stewart-Warner Corp. in Chicago. Steel strip is fed from a coil stand and through a straightening machine at the right of the press. The strip then enters the press which has nine die stations of which seven stations are used to form the housings. Operations at the seven stations are: 1. Notch coil. 2. Cutoff and draw. 3. Restrike. 4. Trim ends, pierce, and notch. 5. Trim sides and notch. 6. Wipe flange and pierce. 7. Cam pierce. Parts in process are transferred from one die station to another by mechanical fingers. The Verson Allsteel Press Co. press has slide and bolster areas of 54 inches by 108 inches, a 16-inch stroke, and operates at 15 to 30 strokes per minute.

## Controlling Thickness




THICKNESS of aluminum foil being rolled on a four-high nonreversible cold-reduction mill at Kaiser Aluminum and Chemical Corp. is automatically controlled by a system built by Westinghouse Electric Corp. An x-ray gage measures the thickness of the foil as it is rolled and feeds a signal to an automatic gage control when the foil thickness deviates from a desired setting. This control varies the speed of the rolls, changing the coefficient of friction between the foil and rolls as well as strip tension. The system can control the thickness of 0.0007-inch double-foil aluminum (two strips, each 0.00035-inch thick) to an accuracy of 1½ per cent. The rolling mill was built by the Loewy-Hydropress Div., Baldwin-Lima-Hamilton Corp.

# SPECIAL TOOLS CLUE TO HIGH SPEED PIPE MACHINING

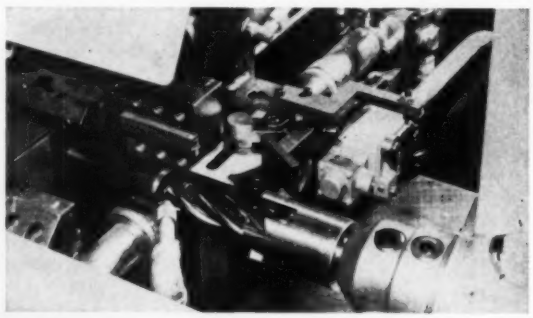
WHAT should be done when demand for a product exceeds a company's capacity to produce the product? American Air Filter Co. Inc. was faced with such a question in connection with its automatic air filters which use a disposable glass fiber filtering element rolled between two spool mandrels. Every time the filter element is replaced, a new one including its mandrel is required.

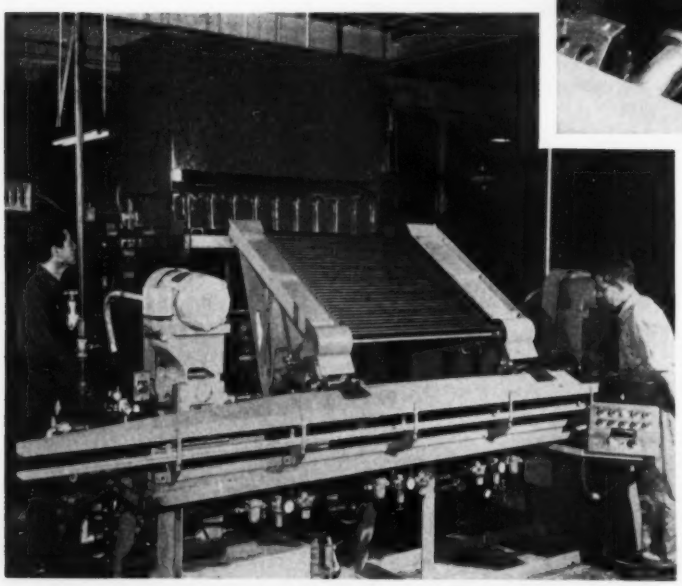
Initial sales were so brisk that requirements for machining mandrels from welded pipe posed a production problem. Each mandrel has to be specially machined at both ends to fit driving pins on the filter equipment. This was done with turret lathes, but the number of lathes available was not sufficient to handle mandrel demands and operations on other parts. As a result, 60 per cent of mandrel production had to be subcontracted.

American Air Filter's industrial engineer felt that rather than acquire more turret lathes he could devise a better process and free the lathes on hand for other requirements. With the help of a new tool from Morse Twist Drill & Machine Co. a process was developed which reduced machining time per mandrel from 8.2 minutes to 0.73 minute. The new process is expected to save at least $16,000 per year.

The new process was based on the theory that a single automatic operation could combine the numerous manual steps required with a turret lathe. The machine developed includes a bed on which the pipe is automatically positioned and clamped after being fed from a hopper. An upright on each end of the bed contains a standard milling head carrying one of the special tools. Feed of the heads is controlled by an air-hydraulic system so that work can be performed simultaneously on both ends of the pipe. An ejecting device automatically removes the mandrel after machining is completed. The machine operator loads the hopper and supervises operation of the machine.

In a single operation the special tools ream, bore, finish outside diameters, and face shoulders. The cost of each special tool is about the same as the cost of separate tools required on a turret lathe. Although the spool mandrels require a tolerance of only plus or minus 0.005 inch, the new process holds a tolerance of minus zero to plus 0.001 inch with no increase in costs.



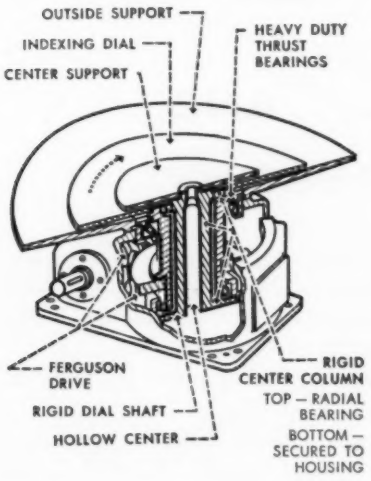


Special machine using two special tools automatically machines both ends of mandrels being made from welded pipe. The installation greatly reduces time for operations formerly done on several turret lathes. Inset shows close-up of machining area for one end of the mandrels.

# How INDEX TABLE *DESIGN* affects INITIAL PRICE and TOTAL COST

Study these drawings to see how the design of an index table affects total costs of an installation. Some tables may be priced lower than others initially, but the additional charges for auxiliary items to adapt them to production requirements, added to maintenance and downtime costs, can make a drastic difference in **the total price.**

**FIG. 1—FERGUSON INTERMITTOR**




The Ferguson Intermittor, indexed by a roller gear drive which operates a minimum of 8,000 hours at speeds up to 2,000 indexes a minute without maintenance, needs no auxiliary locking. It is designed for high speed operation and incorporates rigid integral supports for tooling to eliminate expensive segmental components. The Intermittor dial is supported by tapered roller thrust bearings to withstand heavy loads with little friction. A stationary center tooling support is held rigidly at its top by anti-friction radial bearings and at the bottom by a flanged base bolted to the housing. Hollow center of the support may be used for passage of coolants, fluids, air or vertical shafts to transmit motion to the work surface.

Figures 2 and 3 show typical barrel cam and geneva drive index tables. Their indexing mechanisms limit operating speeds, therefore other components may be "designed down." Shafts and bearings are lighter; frictional support surfaces might be employed instead of thrust bearings and an auxiliary locking or locating device is a costly necessity for even modest accuracy requirements. Tool mounting methods are often provided at additional expense and sometimes even ignored. Difficulties of installation and frequent maintenance downtime can increase total cost drastically.

**FIG. 2—BARREL CAM TYPE**

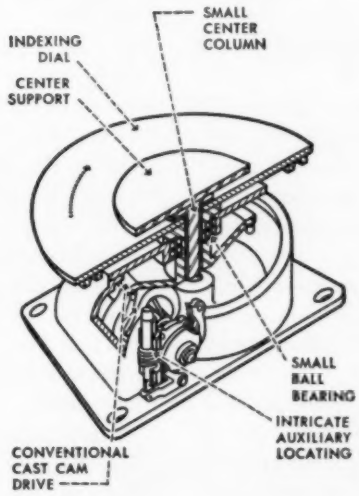
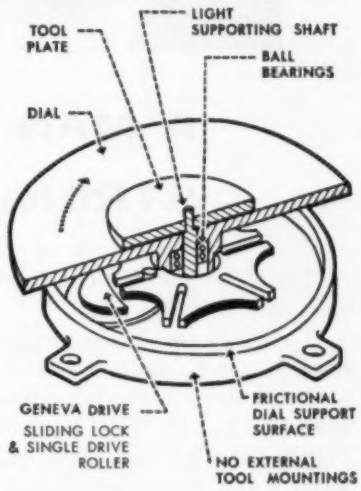



**FIG. 3—GENEVA DRIVE TYPE**

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Circle 696 on Page 19

HAROLD S. BLACK, LAMME MEDALIST

# A MAN WINS A MEDAL...AND STRENGTHENS A PHILOSOPHY

The search for the "hitherto unattainable" sometimes ends in strange places.

For years Bell Laboratories engineer Harold S. Black pondered a problem: how to rid amplifiers of the distortion which unhappily accumulated as signal-transmission paths were made longer and amplifiers were added. There had been many approaches but all had failed to provide a practical answer.

Then one day in 1927 the answer came—not in a research laboratory, but as he traveled to work on the Lackawanna Ferry. On a newspaper, Mr. Black jotted down those first exciting calculations.

Years later, his *negative feedback principle* had revolutionized the art of signal amplification. It is a principal reason why telephone and TV networks can now blanket the country, the transoceanic cable is a reality, and military radar and missile-control systems are models of precision.

For this pioneer achievement, and for numerous other contributions to communications since then (some 60 U. S. patents are already credited to him), Mr. Black received the 1957 Lamme Medal from the American Institute of Electrical Engineers. He demonstrated that the seemingly "unattainable" often *can* be achieved, and thus strengthened a philosophy that is shared by all true researchers.

He is one of many Bell Telephone Laboratories scientists and engineers who have felt the challenge of telephony and have risen to it, ranging deeply into science and technology. Numerous medals and awards have thus been won. Two of these have been Nobel Prizes, a distinction without equal in any other industrial concern.

Much remains to be done. To create the communication systems of the future, we must probe deeper still for new knowledge of Nature's laws. We must continue to develop new techniques in switching, transmission and instrumentation for every kind of information-bearing signal. As never before, communications offer an inspiring challenge to creative men.

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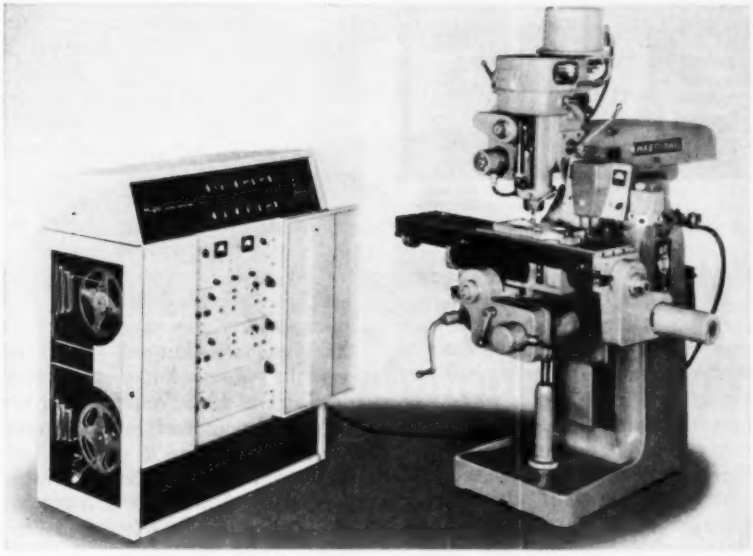
**For detailed information and literature, use card on page 19.**

## Magnetic Tape Control Programs Machine Tools

SYSTEM uses recorded magnetic tape program for the automatic control of machine tools. Feature of the system designed by **Micro-Path Inc.**, 5221 West 102nd St., Los Angeles 45, Calif., is that the recording is carried out by moving a controlled slide through the motions desired, rather than using a computer input. The recording controls are designed so that programming can be carried out at the controlled machine. Through the use of a recording table or a programming table, the recording can be carried on at another location, for example, the Planning or Tool Engineering Department.

A positional control is supplied for each controlled axis of the machine. It allows the operator to direct slide movement and to set feed rate in response to the direction and amount of movement of the control. A toggle switch is used to select either a high or low feed range. In programming, the operator sets the controlled slides to a reference point with the recording controls inoperative. Once at the reference point, the accumulating position reader and dial indicator are set to zero. After switching to record, the operator only needs to manipulate the control, causing each slide to move in the desired direction until the required dimension is indicated in the reader and dial indicator.

As the electronic system generates pulses to move the slide according to the operator's setting of positional control, pulses are also recorded on the proper channel of the magnetic tape. By manipulation of the control, both rapid ad-



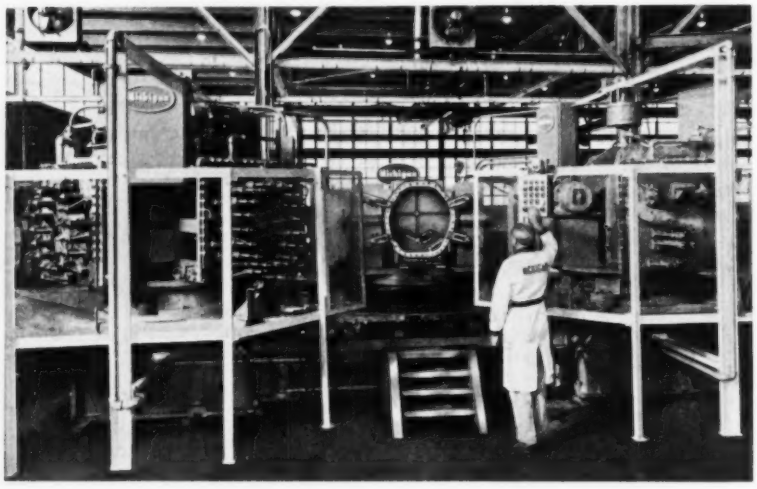
Magnetic tape control system in this example has been applied to a new milling machine. It can also be retrofitted to existing machines. Program for the machine cycle can be recorded by operating the machine through the desired cycle under manual control.

Automatic control system and the programming table shown can be used to record a program at a point remote from the machine to be controlled. The design of the table makes it possible to produce programs from drawings or templates up to forty times normal size.

vance and slow approach can be programmed into the recording. Once at the desired position, the operator can program all auxiliary functions necessary to complete the machining operation such as spindle start, quill down, coolant on, etc. This process is repeated for each successive point until the program is completed.

A contour recording stylus is provided to permit the operator to exercise simultaneous control over positioning of two axes. Through operation of a selector switch, the recording stylus can be made to control any two of three axes. To program a continuing machining process in three axes, a two-axis program would be recorded in one plane with an automatic cutter advance after contouring had been completed at one level of the part.

*Circle 401 on Page 19*



## Dual Turret Drilling Machine

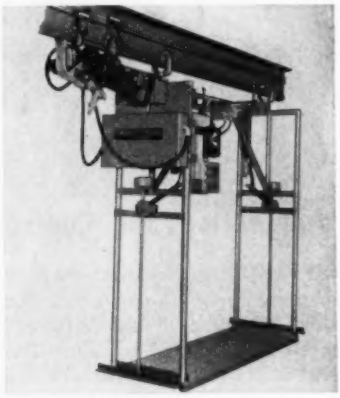
Horizontal, rotary, turret machine is designed for doubled-end drilling, reaming, tapping, boring, chamfering, and spotfacing of 13 different sizes and styles of commercial gas meter bodies. It can handle both cast iron and aluminum workpieces, with an output of 10 parts per hour. Machine consists of two hydraulic index tables; a 4-station index table on one side; and a 2-station index table on the other side. Between the two tables a horizontal feed unit is mounted. On the platen of the feed unit, a 3-station hydraulic index table is mounted. This index table has hydraulically actuated hold-down clamps and supports either one of two work-holding fixtures that are provided with the machine.

The machine cycle is automatic, except for loading and unloading. In operation, the part is loaded on the center index table under manual control. The operator clamps the part in position, closes and locks the safety gates, and selects the cycle. The part is indexed 90 degrees. The number one head on the 4-station turret moves into position. Next the table on which the part is mounted moves toward that turret in rapid feed; then to the required depth at proper feed for drilling. The part is withdrawn far enough to permit indexing of the turret to another group of drills, and the drilling cycle is repeated. The next index presents the tapping spindles for the first group of taps. Another index presents the tapping spindles for the second group of taps. After withdrawing from the second group of taps, the part indexes 180 degrees and presents the face of the part to the 2-position turret where the same functions are accomplished. Upon completion of the operation, the part is withdrawn, and the machine automatically indexed to present the workpiece to the operator for unloading. All moving parts in the machine are automatically lubricated and coolant is supplied to all spindles. **Michigan Special Machine Co.**, 11449 Timken Ave., Warren, Mich.

*Circle 402 on Page 19*

## Transfer Unit

Designed for the transfer of lightweight sliver cans between textile carding machines and spinning frames, unit can be set up to



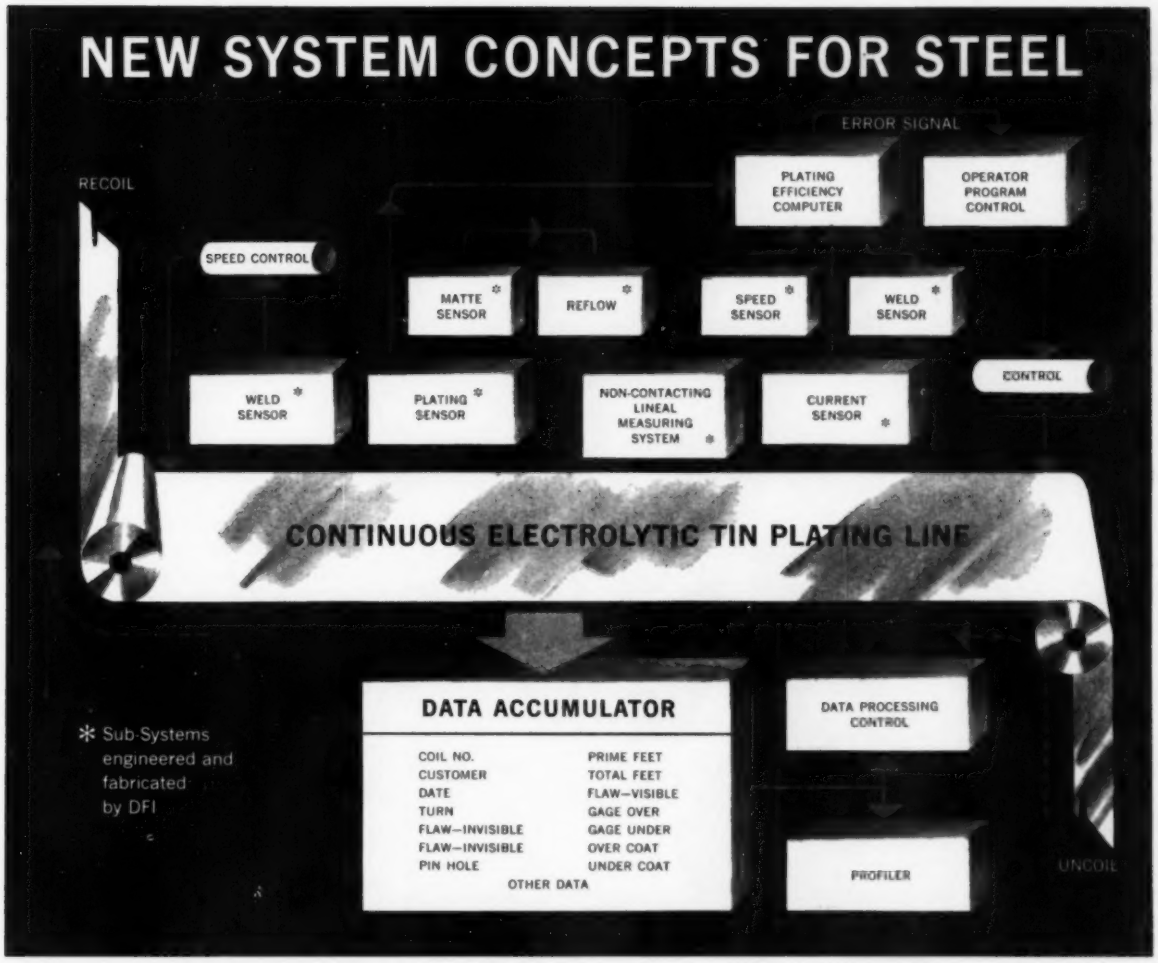
automatically travel to any one of eight stations, stop for loading, and then reset to automatically return to the home station. It is propelled by a tractor unit at 90 fpm throughout an electrified monorail system, which includes a power operated track switch and monorail track loop.

The carrier can be stopped anywhere in the system by placing an obstruction in its path so that bumpers on carrier ends actuate limit switches. A typical program is as follows: First the operator presses the *Automatic* button; second he sets the *Forward* travel selector; third, turns the *Selector* dial for the desired station; and fourth, presses the *Stations* button to start the unit on its way and turn on the control panel light. When the unit reaches the station that is selected, a limit switch stops the carrier, the controls are reset, and the light turned off. After the carrier is loaded, an operator presses the *Home* button. **American MonoRail Co.**, 1111 E. 200 St., Cleveland 17, Ohio.

*Circle 403 on Page 19*

## Transistor Test Set

Instrument automatically tests transistors. It conveys them at a maximum rate of 2400 units per hour through a line of 14 test stations. A series of up to 38 tests are performed including tests for orientation, short circuits, 15 dc tests,




# Sensory techniques for process control

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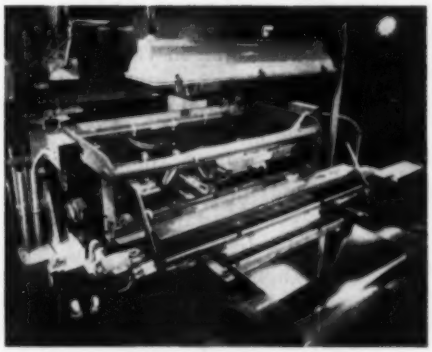

*DfI Non-Contacting Lineal Measuring System in operation at Western Pennsylvania tin plate mill. This particular unit "senses" footage with an accuracy of .1% over a dynamic speed range of 300 fpm to 2400 fpm.*

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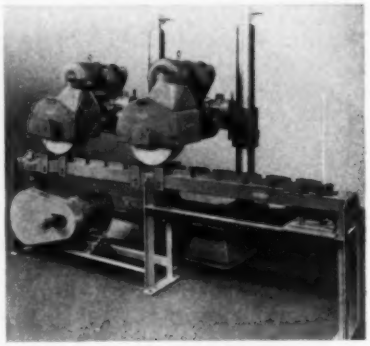
and 21 ac tests. In operation, the transistor is manually clamped in a block with one hand. A roller chain carries it through all test stations. In the event of failure, the transistor is automatically rejected from the test block by a stream of compressed air. Satisfactory transistors are automatically ejected into sorting bins at the end of the test.

Four types of environmental units can be supplied. One raises the temperature to 85 C by controlled air heating. A refrigeration unit lowers temperature down to −55 C. Two other types of heating and cooling units are normally used for diode testing only. These are oil bath units in which temperature is maintained constant at either 85 C or −55 C. **Designers for Industry Inc.**, 4241 Fulton Parkway, Cleveland 9, Ohio.

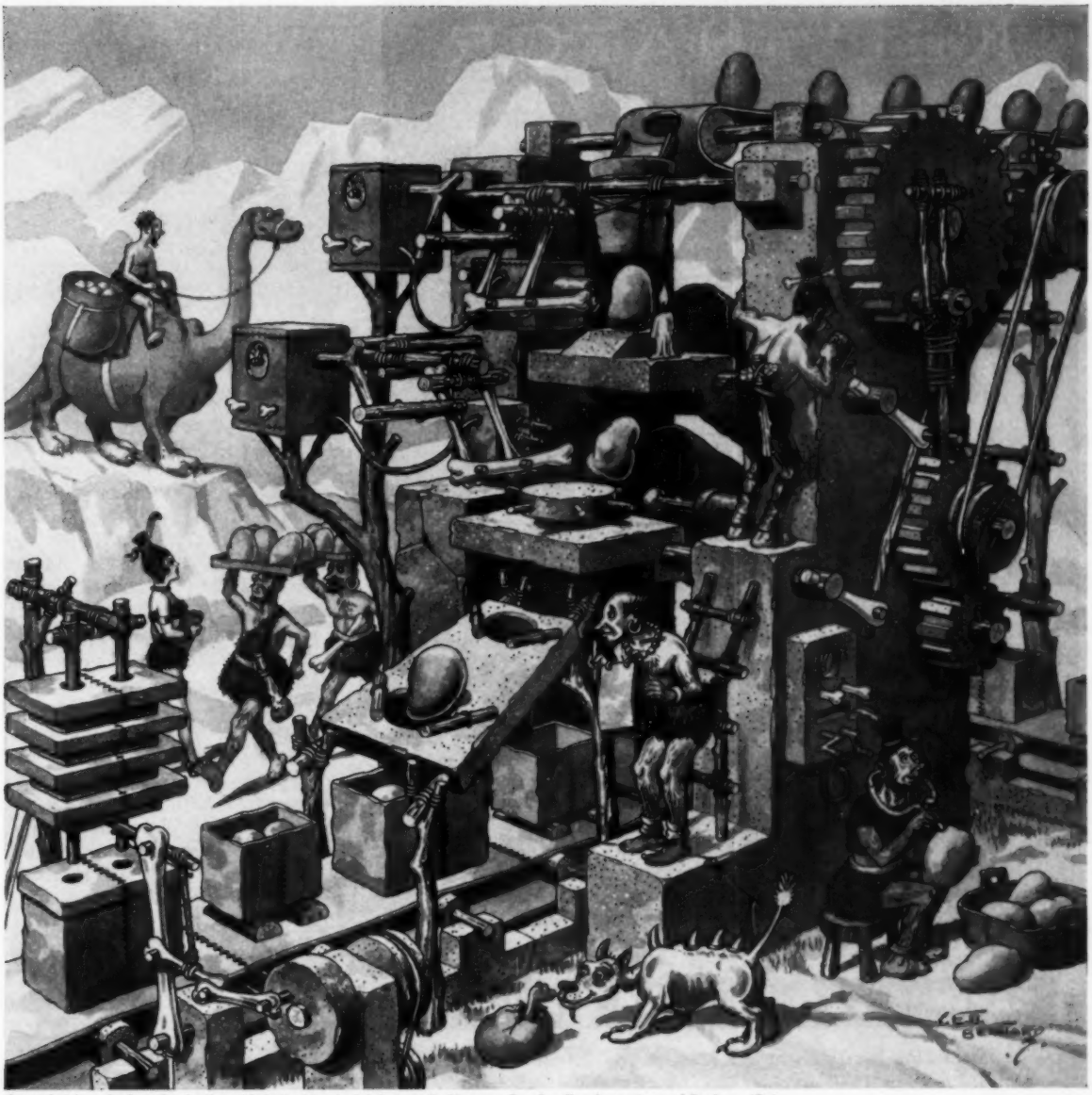
*Circle 404 on Page 19*



## Polishing & Buffing Unit

Straight-line buffing and polishing machine is adaptable to the finishing of parts such as nameplates, door handles, drawer pulls, hinges, and ornaments. Adjustable lathes can be positioned around the machine for tangent or wide-wheel cross-cut buffing operations. Machine consists of an 8-foot long conveyor unit and adjustable lathes that perform the buffing operations. Additional conveyor sections can be added when finishing requirements call for more lathes. The conveyor has a chain type drive and individual platens that carry the work fixtures. The platens can be of either horizontal or follower-return type. **Acme Mfg. Co.**, 1400 E. Nine Mile Rd., Detroit 20, Mich.

*Circle 405 on Page 19*



An early triumph of mechanization, this is the Wonderful Automatic Dinosaur Egg Candler, Inspector and Packer. (Date, ca. 96,000 B.C.) Part of a special pictorial history of automation by Barkley & Dexter, Inc. (Number two of a series.)

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Circle 699 on Page 19

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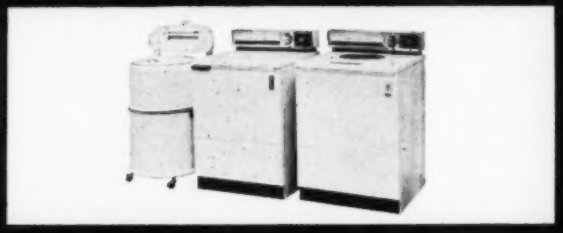

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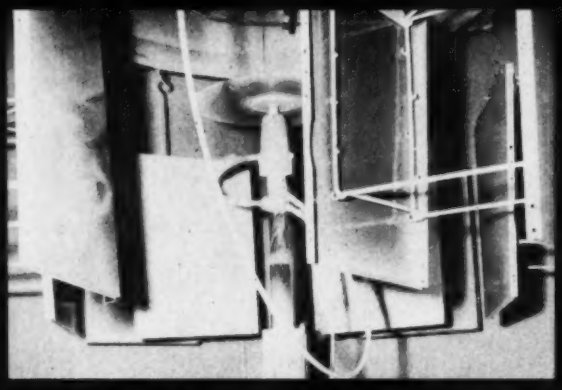

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Demonstration tests in the Ransburg labs indicated substantial savings in finishing costs, but in actual production, SAVINGS ARE EVEN GREATER than estimated. That's why Kelvinator is now considering RANSBURG Electrostatic Spray Painting for other products of their "white goods" line: Refrigerators . . . Home Freezers . . . Ice Cream Cabinets . . . Electric Ranges, as well as some components.

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RANSBURG

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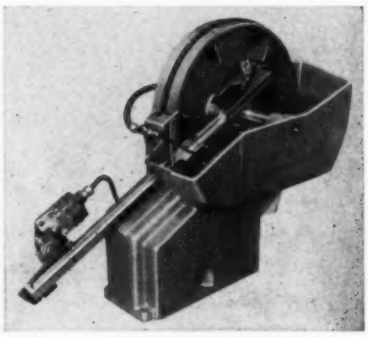
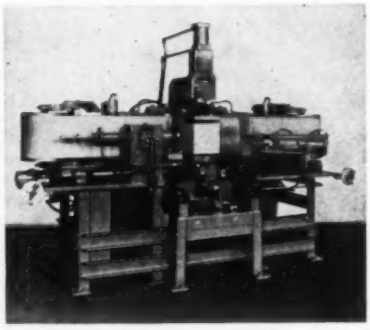


## Parts Feeder

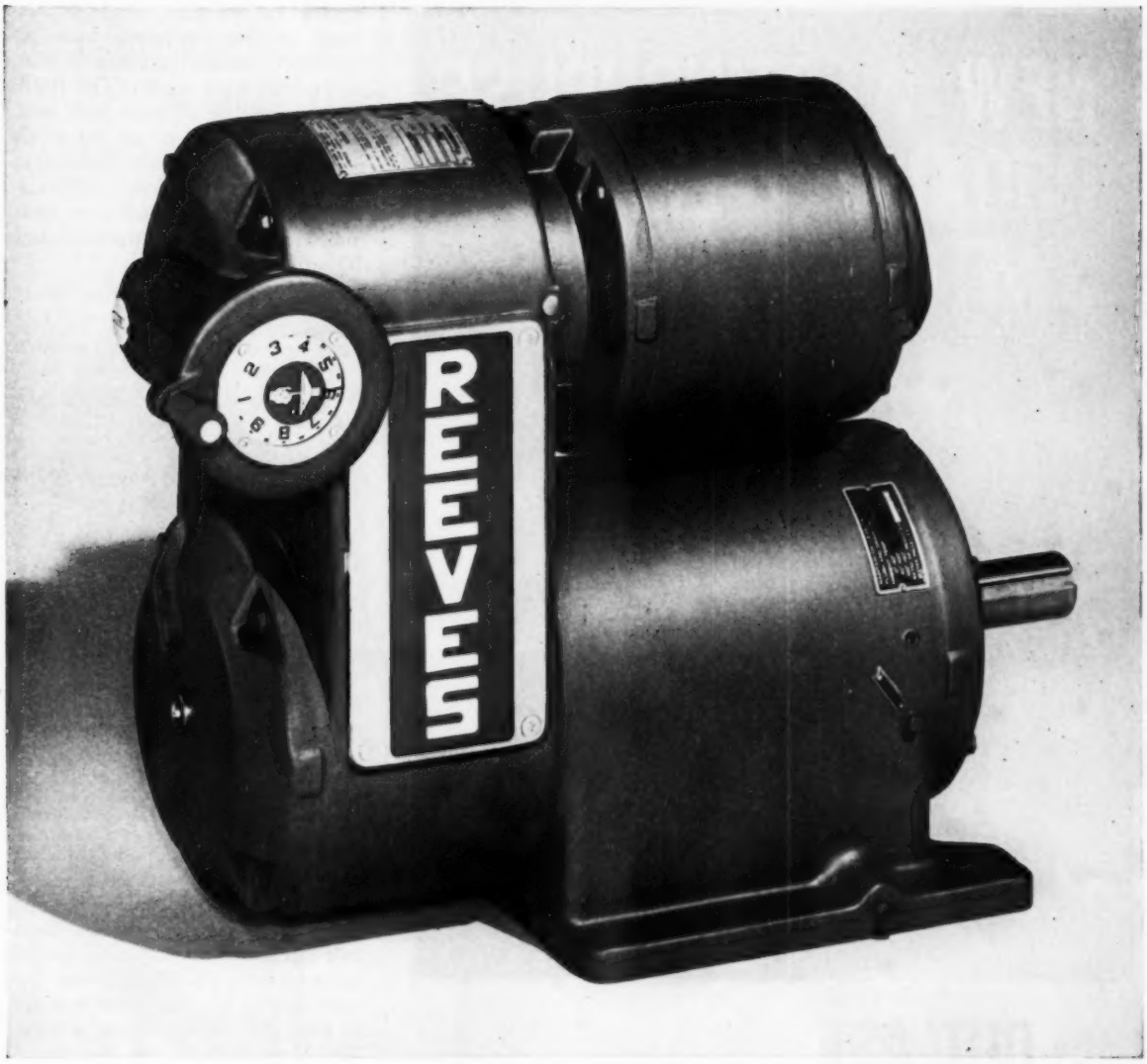
Unit has a motor-driven drum, is capable of handling up to 200 parts per minute. It can be arranged to operate with screwdrivers, positioners, or other types of assembly equipment. The bowl of the feeder has a capacity of 700 cubic inches. Feature of Model FE-103 is that the drum cleats which deliver the parts to the track are fabricated from spring steel and molded rubber. This arrangement provides a gentle, positive action which prevents damage to the piece parts. In the illustration, the feeder is equipped with a solenoid-operated escapement, but it can also be operated with a ram-type escapement. It also has a needle-type air nozzle for removing misoriented parts from the track. **Dixon Automatic Tool Inc.**, 2300 23rd Ave., Rockford, Ill.

*Circle 406 on Page 19*



## Edge Grinder

Unit is suitable for close tolerance sizing of products which require a great deal of stock removal. Corners of finished products (such as floor tile) are perfectly sharp. Edges are ground parallel and

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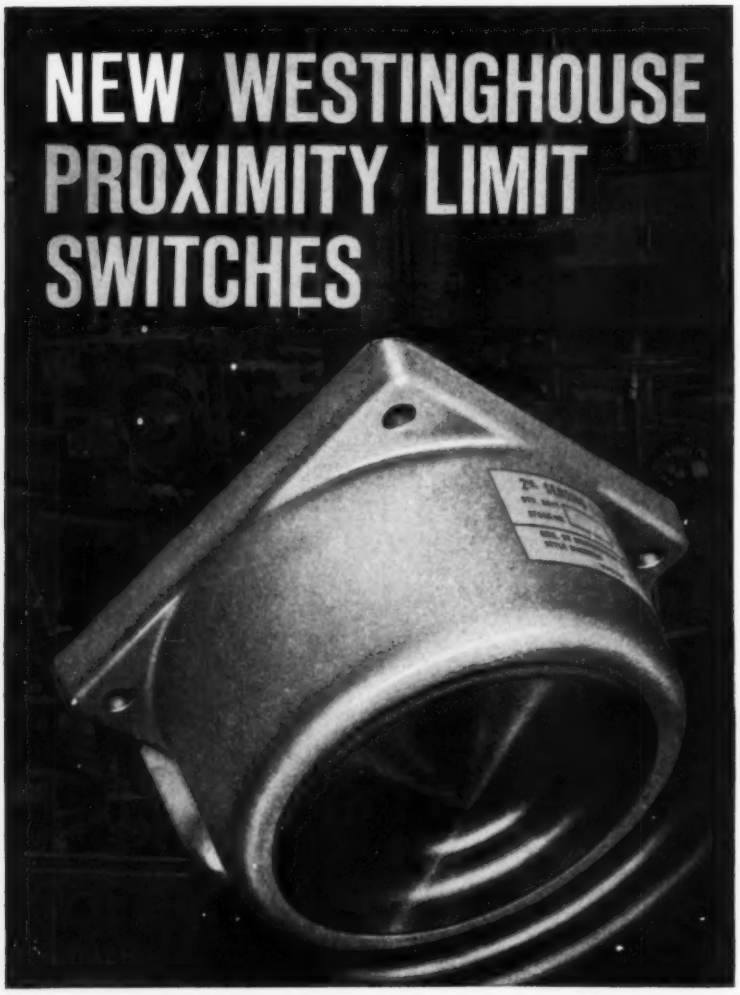
*Circle 701 on Page 19*

# NEW WESTINGHOUSE PROXIMITY LIMIT SWITCHES



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Cost? Westinghouse proximity limit switches cost a little more—but pay for themselves over and over again because they banish expensive machine down time for switch service and replacement.

CALL TODAY for the facts on the new Westinghouse proximity limit switches. Your nearest Westinghouse sales engineer will show you how they can save you time and money. Or write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania.

J-25002

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square. In operation, blocks of material or the workpiece pass between two oscillating abrasive belts, index, and then return. The finish depends on the abrasive belt used. The machine can be set up to allow the blocks of material to make several passes before indexing. Loading can be automatic or manual. **Murray-Way Corp.**, P.O. Box 180, Birmingham, Mich.

*Circle 407 on Page 19*

## Drilling Machine

Equipment is composed of four units that drill 16 smoke holes in pistons for diesel engines at a gross rate of 100 parts per hour. Each unit drills four holes equally spaced in two rows. The single work fixture indexes for one revolution on its own axis, 90 degrees at a time. The large bore in the bottom of the piston fits over a locator in the fixture. An air cylinder clamps the part down during the working cycle and unclamps it after the last operation. **Kingsbury Machine Tool Corp.**, Keene, N. H.

*Circle 408 on Page 19*

## Web Splicer

Machine can automatically splice the leading edge of a new roll of wrapping material to the tail end of the depleting roll, trimming the tail end of the depleting roll. The splicer attaches to and will fit all web consuming machines for webs up to 25 inches wide. Pressure sensitive tape can splice all modern wrapping materials. Existing roll

# Louden Monorail
## cuts the cost of
# Interplant Transport

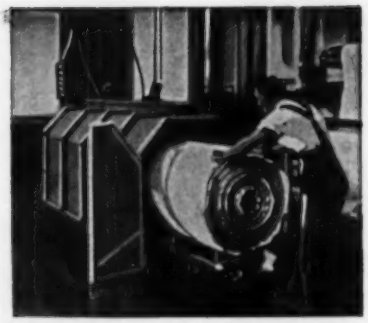
As companies grow and expand production facilities, the problem of interplant transport of materials, parts or semi-finished products is often encountered. Time and again Louden Monorail proves to be the perfect answer. With Louden's Selectomatic Control, such an interplant transport system can be virtually *automatic*.

The Louden Selectomatic Interplant Transport System at the Marion, North Carolina, plants of the Clinchfield Manufacturing Company is a good example. Here the problem developed of transporting tons of cloth daily between three separate buildings. 650 feet of Louden Monorail with a weather proof car in almost continuous operation provides the perfect answer. The car can be raised and lowered as required for charging and discharging loads; the destination desired is preset by the control; transport is speedy, trouble-free, automatic. It is estimated three men with trucks would have difficulty doing the same job.

Louden Selectomatic Interplant Transport Systems can do many things not required in the Clinchfield installation described. It can automatically transport materials unattended from point to point anywhere in or about your plant, and it can select the shortest and most direct route to its destination. It can travel from floor to floor and building to building, open doors to let itself through and close doors behind it . . . building doors, floor doors, oven doors. It places loads in ovens or in banks of infra-red dryer lamps, turning the heat on and off as needed. It stops promptly when there is a load ahead or when it does not have the right of way, and resumes travel when the way is clear. It stops accurately at its destination and even loads and unloads its own carriers with certain classes of materials. It returns empty carriers to point of origin or places itself in storage awaiting its next call.

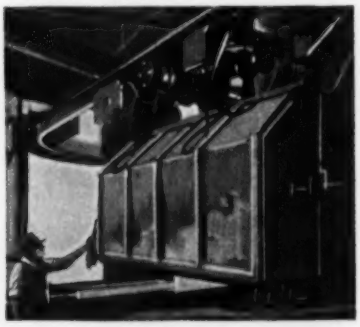
Louden Automatic Materials Handling is the guaranteed product of the pioneers and oldest company in the field of specialized monorail handling. Both the Louden field representatives and the factory engineers are highly trained specialists in the field of overhead materials handling. When you have a materials handling problem or any plant problem involving lifting and transporting loads, call on Louden for suggestions. This will cost you nothing but may prove to be the most profitable move you have ever made.

**THE LOUDEN MACHINERY COMPANY**
**506 Broadway, Fairfield, Iowa**
A Subsidiary of Mechanical Handling Systems Inc.

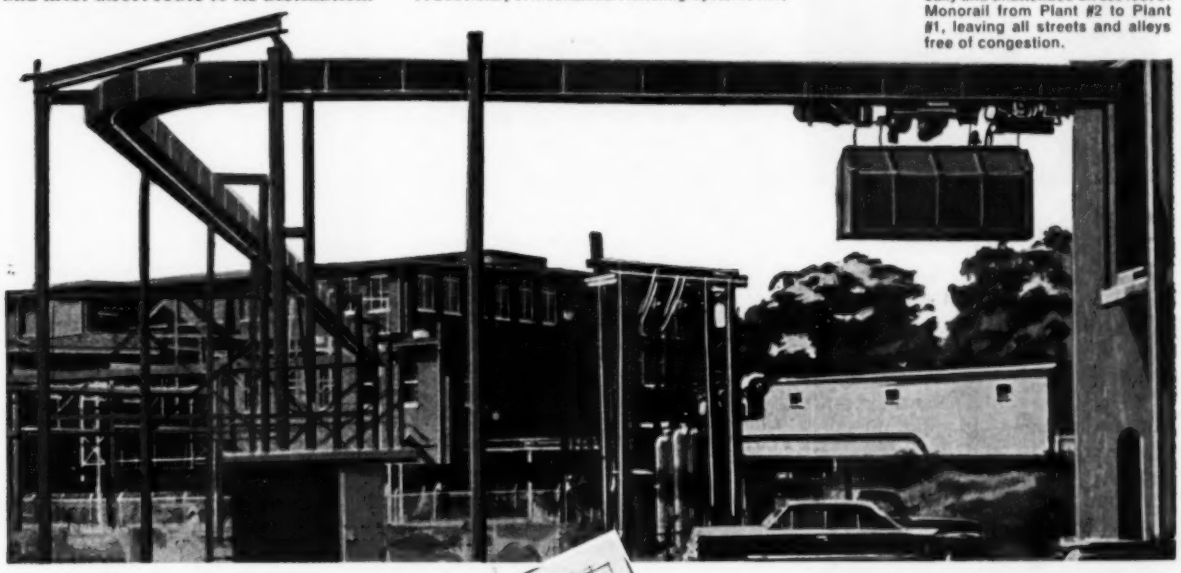


Operator loading carrier with two 650 pound beams of domestic print cloth prior to transport from loom room to cloth room.

Below:
Operator raising carrier into position, selecting destination by push button. Carrier automatically stops at desired destination.



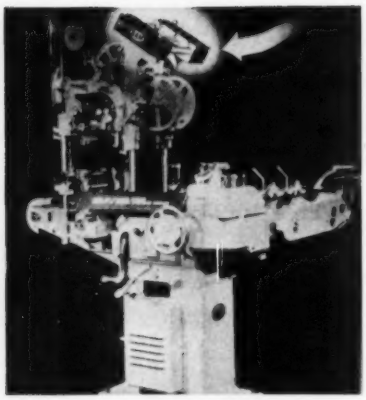
Below:
Carrier completing trip automatically and unattended on 650 feet of Monorail from Plant #2 to Plant #1, leaving all streets and alleys free of congestion.



***NEW***. . . 52 pages of illustrated applications . . . industry by industry. Get the latest and most complete information on planning and equipment selection for the best in modern materials handling. Write today for your copy "COST-CUTTING WITH MONORAIL AND CRANES."

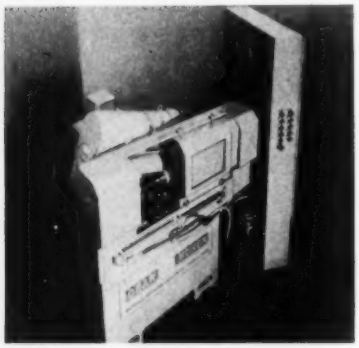
**Louden**
**MONORAIL & CRANES**


Circle 703 on Page 19



stands can be used. For machines with one existing stand, another can be added for splicer installation. **Butler Automatic Machine Inc.**, 205 Broadway, Cambridge 39, Mass.

*Circle 409 on Page 19*

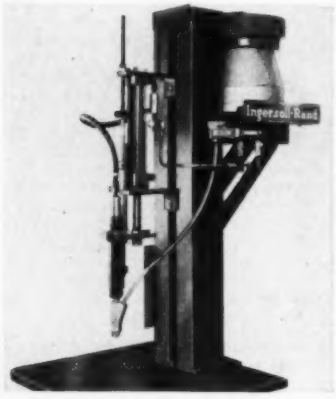


## Gear Honing Machine

Gear tooth honing machine provides four separate honing methods. These include: Honing with backlash in conjunction with the patented honing lock; zero-backlash operation with precision pressure control in conjunction with the patented honing lock; constant pressure operation with an automatic mechanical wedge-type back-up eliminator; and constant pressure operation with overload relief provided by an adjustable leaf spring back-up protector. Gears up to 4-inch pitch diameter can be honed on machines equipped with an automatic loader.

Design of the machine is that the abrasive-impregnated, gear-shaped honing tool is meshed with the work gear in crossed axes relationship. During the honing cycle, the direction of rotation of the honing tool is reversed while reciprocating motion between the honing tool and work gear is made in a path parallel to the axis of the gear. Features of Model GHD include: Straight honehead action and a positive mechanical drive for the hone. A clutch in the hone drive protects the hone from overloads. The honer is available in three styles: Automatic, standard, and manual. **National Broach & Machine Co.**, 5600 St. Jean Ave., Detroit 13, Mich.

*Circle 410 on Page 19*



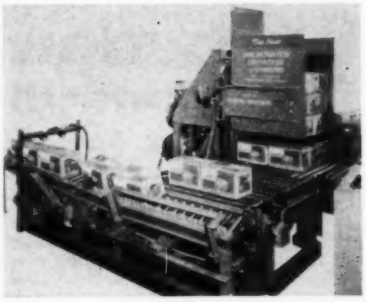

## Automatic Screw Driver

Auomatic screw driver runs screws in 1½ seconds, features rapid pattern changeover. Powerheads can be located as closely as 2 inches center-to-center. Vibratory or barrel feeders are used, and each unit will feed up to four powerheads. Powerhead stroke is adjustable up to 6 inches maximum. Three different power ranges are provided by three different air motors for predetermined torque control. In each power range, the motors run to stall, driving screws to a preset, accurate torque. Throat depth ranges from 8 5/32 to 14 inches from center line of powerhead to column. **Ingersoll-Rand Co.**, 11 Broadway, New York 4, N. Y.

*Circle 411 on Page 19*

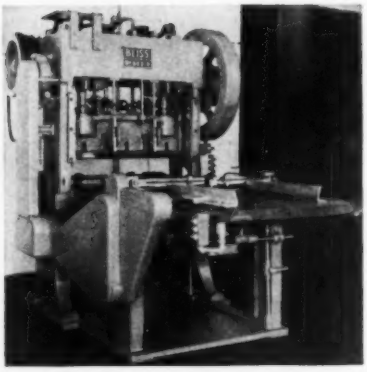
## Carton Unstacker

Air cylinders are used for hoisting, clamping, and pallet movement on carton unstacker. The air



operation provides a cushioning effect which prolongs the life of both the machine and the cases. All conveyors and the pallet stacker included as a part of the machine are electric power driven. Approximately 50 cfm of air is required for operation. Capacity of the unstacker is 40 to 45 cartons per minute under normal conditions of delivery of pallets. **Standard Conveyor Co.**, North St. Paul 9, Minn.

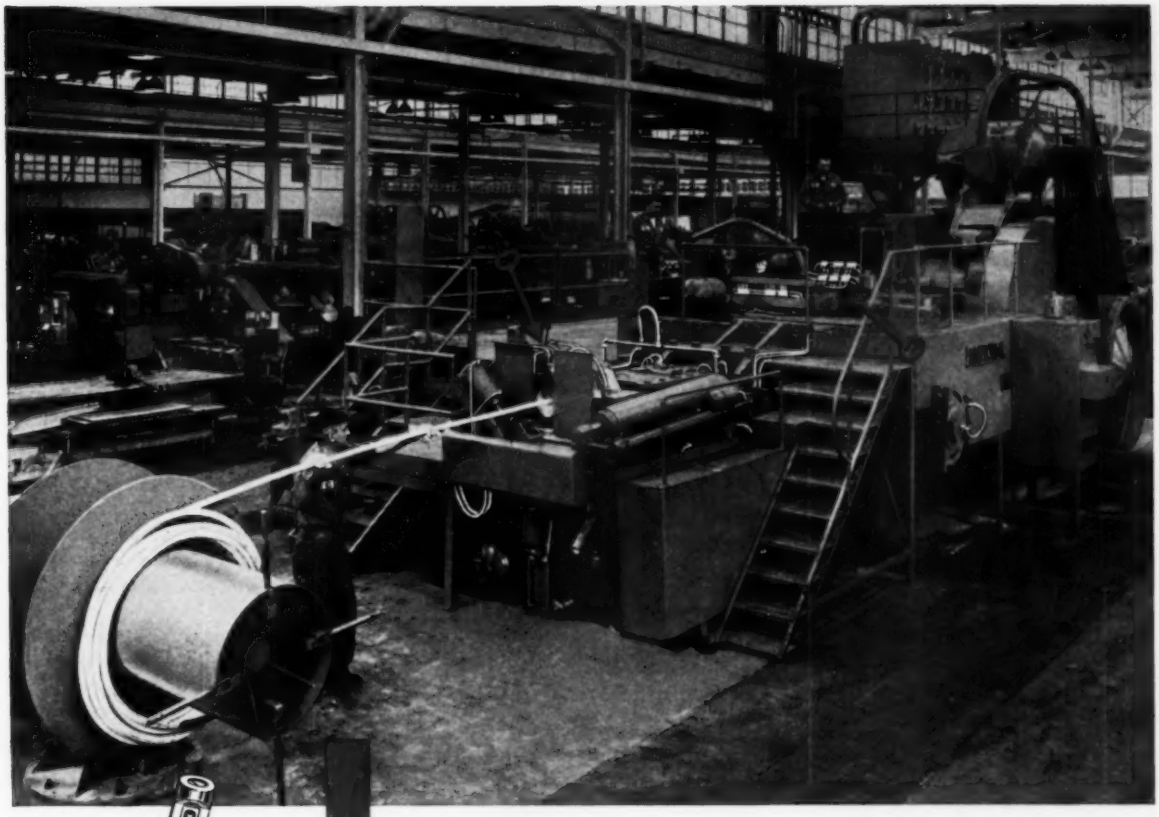
*Circle 412 on Page 19*



## Multiple Die Press

Multiple die press can produce screw caps, tape cans, shoe polish cans, and similar items at speeds ranging from 100 to 125 strokes per minute. An entire lithographed sheet of tin plate or aluminum can be fed to the multiple dies, producing 8 or more caps at each stroke. Machine is available in two sizes. The smaller unit, Model 660D can produce eight 48 or 53 mm caps at each stroke. The larger unit, Model 6100B, can produce ten 70 mm caps per stroke. **Press Div., E. W. Bliss Co.**, 1375 Raff Rd. S.W., Canton 10, Ohio.

*Circle 413 on Page 19*



FARVAL—Studies in Centralized Lubrication No. 238

# Farval automatically lubricates 138 bearings on world's largest Boltmaker

It's a 1¼-inch cold forger, designed and built by National Machinery Co. for the Cleveland Cap Screw Co., Cleveland, Ohio. This versatile machine automatically produces hex head cap screws. It draws steel rod to wire size, cuts it to proper length, extrudes the blank, heads, trims the head, points the end and then rolls on threads, all this at the rate of 38 complete screws per minute.

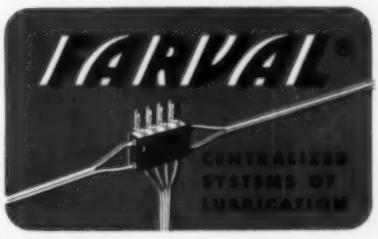
A Farval timeclock-controlled, motor-driven lubricating system guarantees against failure of the machine's 138 vital bearings, as well as supplying spray lubrication for the cold-forger's chain drive. If bearings should fail on such a high output machine—production costs skyrocket, profits take a nose-dive.

Write for revised Bulletin 26-T, which shows how Farval can extend both bearing and gear life on new machinery—as well as on older equipment now in use.

**Farval Division** • Eaton Manufacturing Company
3265 East 80th Street • Cleveland 4, Ohio

**KEYS TO ADEQUATE LUBRICATION**

Wherever you see the sign of Farval—familiar valve manifolds dual lubricant lines and central pumping station—you know steel mill equipment is being properly lubricated.



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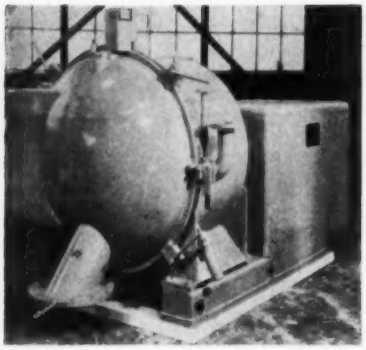

## Centrifuge

Equipment is capable of removing solids like polyolefins, vinyl resins, corn starch, titanium, aspirin, and acrylic resins from a liquid carrier. It can process materials under 150 pounds per square inch internal pressure at speeds of 100 Gs. When processing free-draining materials, capacities up to 30 tons per hour are possible. Front door features a clamping and self-aligning seal; the housing also has a self-sealing arrangement for complete pressurizing. The peeler knife of Model HS 40 W enters the cake at increasing depths, with each discharge cycle. Air displacement is controlled during both charging and peeling operations. Machine is powered by a 75-hp motor and provides a maximum drum speed of 1300 rpm. Capacity of the drum is 8 cubic feet. **Chemical Machinery Div., Baker Perkins Inc.,** 1000 Hess, Saginaw, Mich.

*Circle 414 on Page 19*

## Fluid Heating System

Automatic electric fluid equipment provides liquid heat transfer to process equipment such as jacketed pipe lines and kettles, revolving rolls and platens, dies and molds. Model PF consists of an electric immersion heater, motor and high-temperature pump, bypass relief valve, strainer, expansion tank, temperature controls, contactors, and disconnect switches. Unit has dual circuit indicating controllers with stainless steel bulb and capillary directly immersed in the heat transfer fluid for maximum control accuracy. It it adjustable through a range of 100 to 600 F. Ten models are available in both standard and special voltages and phases. Kilowatt ratings range from 4.5 to 80 with btu output from 15,350 to 272,000. **Radcor Inc.,** 7500 Thomas Blvd., Pittsburgh 8, Pa.

*Circle 415 on Page 19*

## Data Input & Output Units

Line of electronic data input and output machines, designated Codewriter, prints characters serially. Both alpha-numeric and numeric-only printout are available. The input machine allows variable data entry and record creation for computer data processing, elements of data collection, typesetting, and for preparing media for automatic control device inputs. The output machine provides a permanent record of complete or exception data for process industry variables such as volume, pressure, and temperature. It can also be used for logging laboratory test results and production variables as shaft rotation, weight, and quantities. **Industrial Products Div., Royal McBee,** 740 N. Main St., West Hartford 17, Conn.

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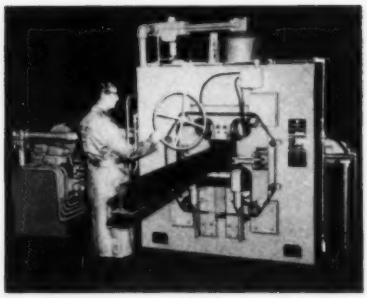
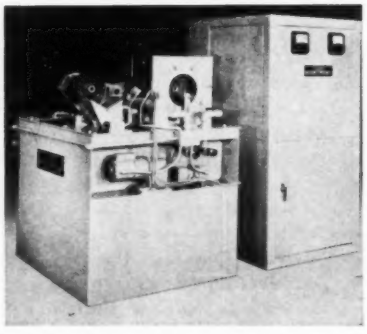


## Rail Straightening Press

Machine can automatically straighten bends in railway rails which have no more than 6-foot to 8-foot radiuses. With the addition of an outboard sensing device on the exit side of the press, it is possible to straighten longer bends by straightening the rail at 6-foot to 8-foot intervals throughout the bend.

The press consists of four cylinders, two with 200 ton pressure and two with 80 ton pressure. The 200-ton cylinders operate vertically; and the 80-ton cylinders operate horizontally. In operation, the rail is fed through the press by a conveyor system. Directions of bends and their location in the rail are indicated automatically. When bends are located, the conveyor automatically stops, the proper straightening ram is energized and the rail is straightened. **Hydraulic Press Mfg. Co., Div., Koehring Co.,** Mount Gilead, Ohio.

*Circle 417 on Page 19*



## Induction Heater

Low frequency induction heater is capable of heat treating track rollers, crane wheels, and other similar parts in diameters ranging

## NEW . . . IMPROVED

# MAGNETIC SWITCH

A new, compact, **improved** magnetic switch . . . neatly contained in an epoxy resin shell. The Post MH-2-P, is a magnetically operated sensing device for industrial applications. This proven product may be used to actuate electronic or mechanical counters, controls, solenoids, relays or other types of circuits. The MH-2-P is easier to mount in areas of limited access, and features a quick disconnect Cannon connector.

The MH-2-P is capable of speeds up to 100 cycles per second, and has a life of many billion cycles. Contacts are single-pole, double-throw, rated at 5 amps. non-inductive.

The switch is operated by the proximity of a magnetic field which is usually provided by an Alnico magnet. When the magnet is moved close to the face of the switch, the switch arm transfers contact; and as the magnet moves away, the switch arm returns. Thus it is possible to operate from zero speed up to a transient magnetic field of only eight milliseconds.

By mounting a magnet on a rotating shaft or wheel, the MH-2-P is ideal for counting revolutions, synchronizing, or timing. The outstanding feature of this switch is its ability to provide a sharp, clean "make and break" with no bounce. This is important because the bounce in all other contactors will cause several counts for each contact closure in high speed electronic counters.

## SPECIFICATIONS

**SWITCH** — Magnetic, hermetically sealed in a high-pressure hydrogen atmosphere in a glass capsule.
**MOUNTING** — Upright, within 45° from vertical.
**CONTACTS** — S.P.D.T. 5 amps. non-inductive (Mercury wetted contacts).
**SPEED** — Zero to 100 per second.
**MINIMUM MAGNETIC FIELD TRANSIENT TIME** — .008 seconds (8 milliseconds).
**LIFE** — Conservatively rated in excess of one billion operations.
**WEIGHT** — App. 3 ozs. **OVERALL HEIGHT** — 5⅜ in.
**ENCLOSURE** — Epoxy Resin. **COLOR** — Grey
**MAXIMUM AMBIENT TEMPERATURE** — 100°F (Consult factory if switch is to be operated at higher temps.)

The usual contact "bounce" is eliminated by virtue of the damping action of a capillary film of mercury.

Datatron

## ELECTRONIC PRODUCTS DIVISION

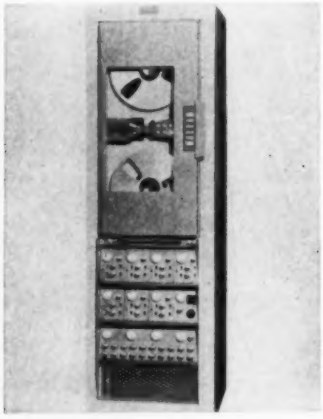
**POST MACHINERY COMPANY**

175 Eliot Street, Beverly, Massachusetts

*Circle 705 on Page 19*

from 6 to 14 inches. The power source can be either a direct line 60-cycle or Multiductor 180 cycle static frequency converter. Feature of the unit is the automatic indexing with parts being carried to heating coil, quench, and back to unload-reload position. Quenching of one part while another part is heating provides high production. **Ajax Magnethermic Corp.**, Youngstown, Ohio.

*Circle 418 on Page 19*



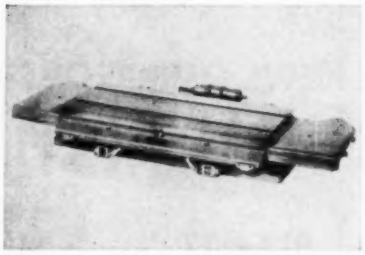
## Video Band Reproducer

Instrument records both analog and pulse signals, has a selection of six speeds ranging from 7½ to 120 ips. Feature of Model CM-100 is the fast frequency response. For example, 1 mc at 120 ips, 500 kc at 60 ips, 250 kc at 30 ips, and 125 kc at 15 ips. Unit has seven tracks, uses ½-inch tape. Over-all bandwidth is 400 cycles to 1.0 megacycle per track. **Mincom Div., Minnesota Mining & Mfg. Co.**, 2049 S. Barrington Ave., Los Angeles 25, Calif.

*Circle 419 on Page 19*

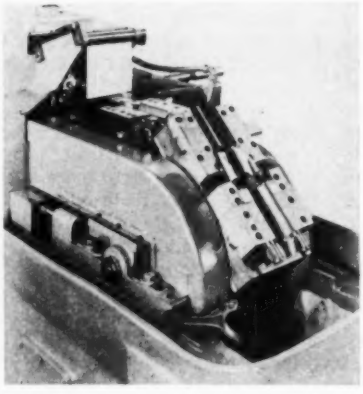
## Slide Table

Slide table provides working and loading-unloading stations or two work positions on the same part. Slide movement is powered by a 3-inch bore air cylinder or a 2-inch bore hydraulic cylinder. The stroke length is infinitely adjustable from 1 to 15 inches. Two stop rods mounted on the ends of the lower



slide member provide adjustment of the stroke length. Regardless of the position of the positive stops, hydraulic cushions take effect ½-inch before contact is made at either end of the stroke. Speed of the cushions is adjustable through a needle valve accessible from the front of the top slide. Working surface of the top slide member measures 30 by 12 inches and is provided with two longitudinal ⅝-inch bolt T-slots, spaced 6 inches apart. Guards at either end keep the dovetail way covered in all slide positions. Table applications include use on turret-type drilling machines, multiple drill head machines, and multiple-spindle boring machines. **Russell T. Gilman Inc.**, 623 Beech St., Grafton, Wis.

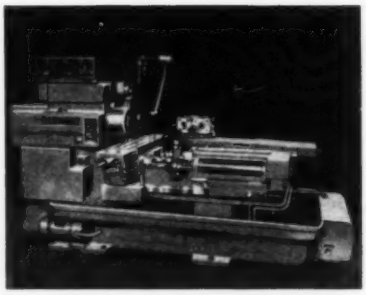
*Circle 420 on Page 19*



## Horizontal Broaching Unit

Continuous, horizontal broaching machine for automotive connecting rods employs a V-belt drive, permitting speed changes if desirable. The belts drive a worm shaft, the power being transmitted through this worm and a worm gear, then through a herringbone-tooth pinion and gear to the driving sprocket. Shear pins are provided in the drive system to protect the machine and broach from breakage. The coolant system for Model 15L can be either integral or left off where central system is employed. The electrical equipment consists of a pushbutton station for machine control, with a special plugging switch for immediate stopping. The automatic plugging switch senses an improperly loaded part and plugs the motor for an instantaneous stop before damage can be done to the machine or the broach. **Foote-Burt Co.**, 18235 Euclid Ave., Cleveland 8, Ohio.

*Circle 421 on Page 19*



## Ram Type Turret Lathe

Automatic ram type turret lathe is capable of handling both bar and chucking work. Spindle speed selection and machine functions such as back feed, right- or left-hand threading, manner of cross slide operation and collet chuck and bar feed operation are preset. All set-up is made from the front of the machine. Cross slide operation is independent of the hex turret. The side carriage can be positioned longitudinally on the bed to suit the work. The cross-slide can be programmed to operate while the turret is waiting at full back position and it can operate simultaneously with the turret or after the turret comes forward. It can also continue to operate while two or more turret stations perform other work. Lathe is available in two styles; Model 4AR has a 2-inch bar stock capacity and Model 5AR has a bar stock capacity of 2½ or 4½ inches. **Gisholt Machine Co.**, 1245 E. Washington Ave., Madison 10, Wis.

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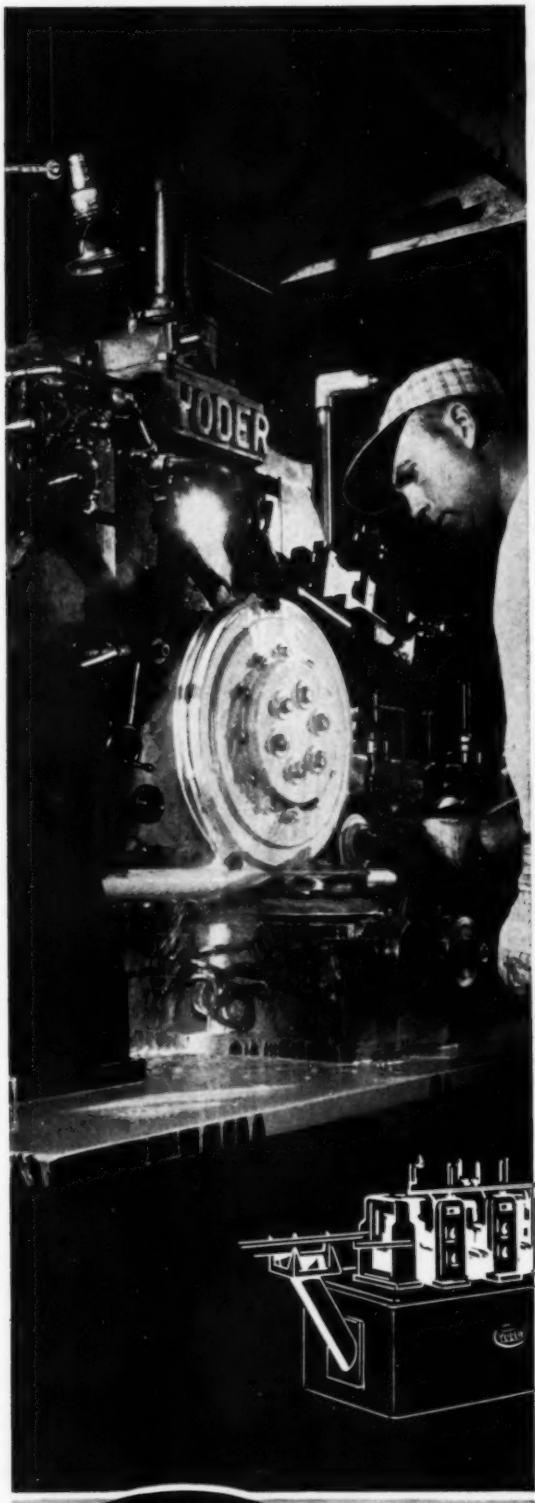
Circle 705 on Page 19




# Yoder Tube Mills speed tailpipe production at AP Parts Corporation

The AP Parts Corporation (Toledo, Ohio), world's largest producer of replacement mufflers and tailpipes, uses 2 YODER Tube Mills to produce more than *300* ft. of 1¾", 1⅞" and 2" tubing per minute.

According to Mr. John Grindle, Plant Engineer, the two-man operated YODER Mills are vital to the production of the entire plant. "YODER Tube Mills earn their keep daily. They are easy to set up, maintain and operate . . . the welds are clean and uniform. We depend on them for constant quality, high production and minimum downtime".

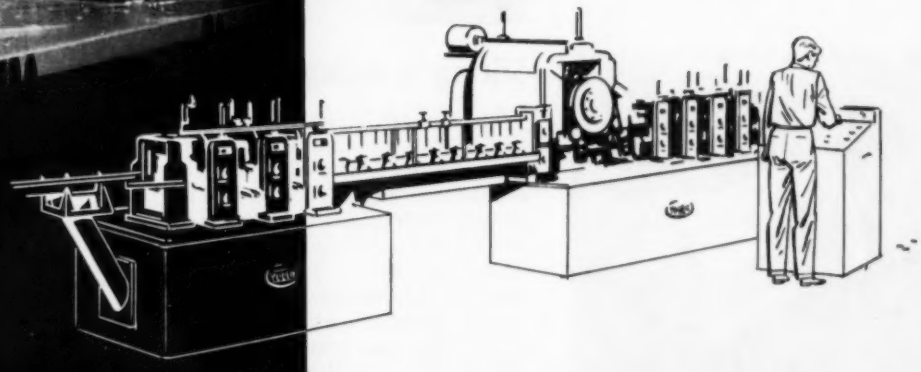
The YODER Tube Mills at AP Parts exemplify the production economies and dependability of all YODER-built equipment, whether it be Pipe and Tube Mills, Cold Roll-Forming Machinery or Slitting Equipment.

If your products require ferrous or non-ferrous pipe or tubing, from ¼" to 26" diameters, there is a YODER Mill designed to produce it economically, accurately and efficiently.

**THE YODER COMPANY**

**5526 Walworth Avenue • • Cleveland 1, Ohio**

For complete information on YODER Pipe or Tube Mills . . . write for the fully illustrated, 88 page YODER Tube Mill Book . . . it is yours for the asking.

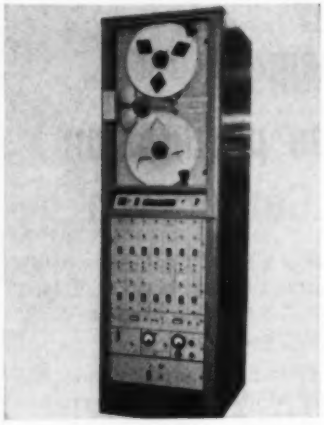


ENGINEERING **YODER** MANUFACTURING

**PIPE AND TUBE MILLS (ferrous or non-ferrous)**

**COLD ROLL FORMING MACHINES**

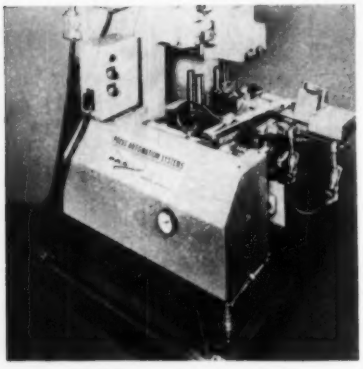
**ROTARY SLITTING LINES**



## Tape Recorder

Instrument can select five modes of recording and playback (analog, FM, PDM, compound modulation, or digital). Changeover is made by plugging in the appropriate signal amplifier. Current amplifiers boost reproduce signal output to a level adequate for parallel driving of oscillograph galvanometers, chart recorders, or other readout devices. Feature of Model 5-752A is the automatic ready circuit. The circuit is energized when the tape is correctly threaded, the follower arms are in place, and the machine is ready for operation. **DataTape Div., Consolidated Electrodynamics Corp.**, 360 Sierra Madre Villa, Pasadena, Calif.

*Circle 423 on Page 19*

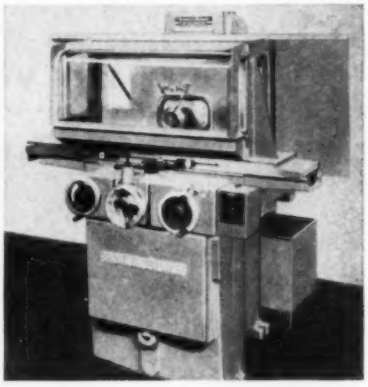


## Press Feeder

Plug-in feeder unit is designed to automate open-back inclinable presses, will feed parts into dies at rates from 40 to 60 pieces per minute. The feeder unit is bolted to the bed of a press by means of an adapter plate. It transfers parts to the die from an operator-fed, preload station located out of the die area. The parts are removed from the die by air ejection or another type of automatic unloading.

The air-powered unit has an arm that travels back and forth to pick up parts from the preload station and place them in the die. The part pickup is accomplished with vacuum-lift, electromagnets or gripper fingers. The pickup arm is mounted on a saddle that is mounted on guide bars with linear ball bushings. The arm is lifted by a cam action at both ends of the stroke to pickup and deposit parts in the die. **Press Automation Systems Inc.**, 25418 Ryan Rd., Warren, Mich.

*Circle 424 on Page 19*

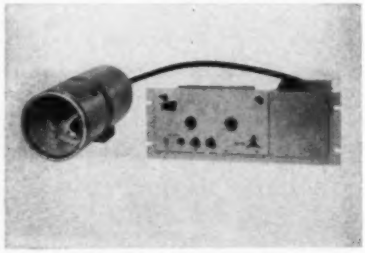


## Slicing & Dicing Machine

Slicing and dicing machine (Model 618) automatically wafers semiconductor materials such as germanium, silicon, and quartz crystals with parallel accuracy to one ten-thousandth of an inch. It consistently repeats in size to plus or minus two ten-thousandths. Unit uses a metal-bonded or resenoid-bonded diamond wheel. With the addition of a wheel sleeve and by ganging wheels, wafers can be diced in quantity with one pass of the table. Where only dicing is required, machines are available without automatic cross feed and indexing mechanism.

The table driving mechanism is infinitely adjustable from 0.100 to 144 ipm with rapid table positioning adjustable to approximately 25 fpm. The table is mounted directly on a fixed bed in V and flat ways. A rugged cast iron upright moves transversely in V and flat ways on the bed casting. Cross feed is automatically actuated at the beginning of each cycle by a hydraulic-mechanical arrangement, accurate to plus or minus two ten-thousandths and adjustable from 0 to 0.1000-inch. Total amount of index is read directly from the handwheel graduated in increments of 0.00025-inch and is adjustable independently of the handwheel to facilitate setup. **Machine Tool Div., Brown & Sharpe Mfg. Co.**, Providence 1, R. I.

*Circle 425 on Page 19*



## Television Camera

Camera is constructed to withstand weather, shock, vibration, noise, salt spray, and dust without an auxiliary protective housing. Model RGS-10 consists of a camera and camera control that are capable of being operated up to 2000 ft apart. Feature of the unit is the automatic setting which self-adjusts the camera circuits for light level changes over a range of 2000 to 1. Another feature is the provision of noise reduction circuits which present a clean picture at low light levels. No additional equipment is required for pickup of visual information. Both the camera and control unit are completely transistorized. The camera will operate at from −20 to +160 F; in noise levels of more than 185 db; and vibration to Mil-E-5272-B. The complete unit draws 15 w, 115 v ac, 50-60 cycle or 400 cycle. **Dage Television Div., Thompson Ramo Wooldridge Inc.**, Michigan City, Ind.

*Circle 426 on Page 19*

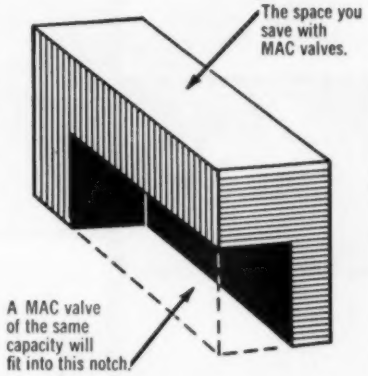
# Cuts Air-Valve Size 67% with New Design

*Also Boosts Performance, Life, and Ease of Service*

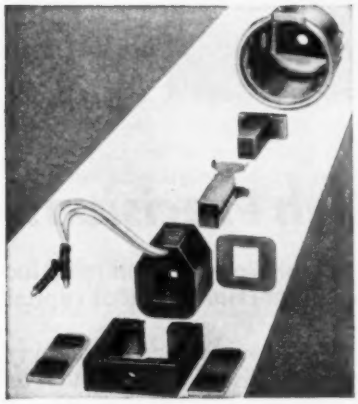
A remarkable new line of pilot-operated air-valves—the MAC series 300—cuts space requirements to ⅓ of that normally required for valves of equal capacity rating.

Not only is the valve extremely simple in operation, reducing cost, but the three moving parts can be replaced in a matter of 1 to 2 minutes without special tools. Life of moving parts is rated at 30,000,000 cycles, minimum.

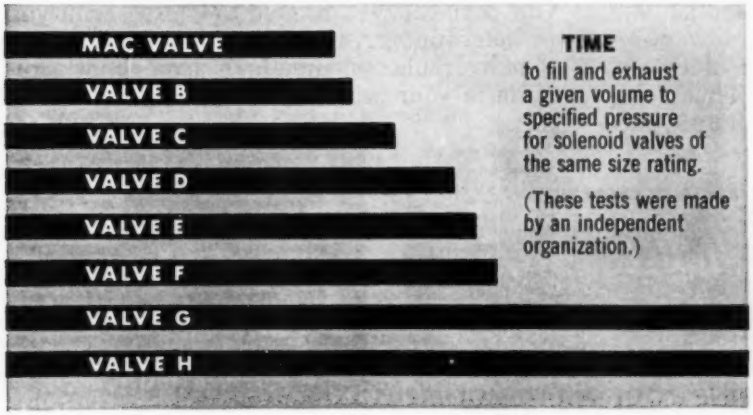
The story of how this was accomplished, together with valve sizes and specifications, is contained in Bulletin #300A available from Mechanical Air Controls on request.




# New Solenoid Boosts Valve Life —Virtually Foolproof, it also has Lighter Draw



A virtually failure proof solenoid which can be completely assembled or taken apart without any tools—but which can't be assembled wrong has been developed by Mechanical Air Controls. It has no welds to break or crack. It has no screws, nuts, bolts or other fasteners to work loose. It has a fully encapsulated water and oil resistant coil. There is no wiring through air valve body. The connections just plug in. The entire assembly floats on rubber mounts, the rubber being in shear. The solenoid has a lower draw because of the lighter push required. The design provides for both locking and manual jogging. It is standard on every MAC series 300 air valve.




*advances in*
**PNEUMATICS**

MAC

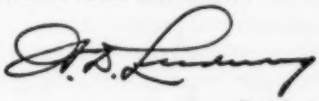
# designing an air valve . . .

There are two ways to design air-valves. One is for a specific job, and no more. For example, a valve in a missile usually has to function only once. Wear life is no problem. The other way is to design a valve for the *toughest* job it might face and then use it on easier jobs, too.

Any engineer would prefer the second way, but he wonders "Won't it cost too much?"; or "Won't I be criticized for providing more performance or life than needed?"

His worries are pointless. The second way doesn't have to cost more. Extra performance and quality can be a free "plus." If you design air-valves for the TOUGHEST jobs they can encounter (as we did at MAC) you can naturally get a simpler, more compact, easier-to-service valve; plus extra performance reserve—all AT LOWER COST.

Why? Once the valve licked the toughest application—where speed, reliability, serviceability and life were MOST vital—we simply standardized for mass production. That's how we wound up with a better and lower cost valve . . . the series 300.



President

MAC

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**NEW YORK**
**MAY 23-26**

# BEAVER BALL SCREWS

## Part of the Secret of Their High Precision!

Tolerances close as .001" maximum error in 10 feet of ball nut travel are not uncommon in Beaver Ball Screws. Spring rates in excess of 20 million pounds per inch are not exceptional. They're specified where system stiffness that permits accurate locating and repeatability, free from backlash and surge, is essential. 90% (plus) efficiency with consequent low power requirements, compactness and reliability are inherent Beaver characteristics. That's why they are used in actuating vital aircraft parts and head slides and tables of precision machine tools as well as critical functions in other capital equipment.

Beaver Ball Screws provide for the moving of massive loads or extreme small parts such as fuel metering devices with equal sensitivity. Our engineers will be glad to consult with you in determining where they may serve better than hydraulic, pneumatic or acme screw actuation in your product. Write for our catalog.

**SPECIFIED BY 22 MAJOR MACHINE TOOL MANUFACTURERS**

Largest manufacturers of precision ball screws

**Beaver Precision Products INC.**
CLAWSON, MICH.

# AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 19.

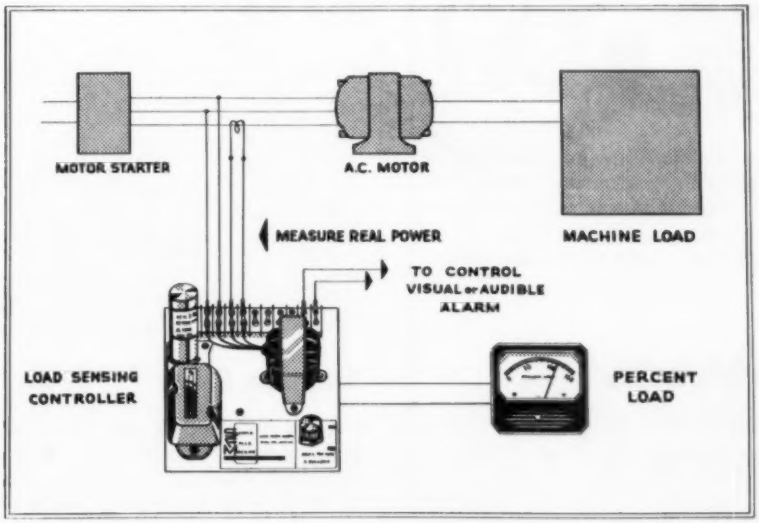
## Process Chromatograph

Process chromatograph which is composed of the control unit (left) and the analyzer (right) makes analyses of up to eight streams.

PROCESS chromatograph can make analyses in less than 30 seconds on some products, features automatic programming of up to eight streams. Designed by **Analytical & Control Div., Consolidated Electrodynamics Corp.**, 360 Sierra Madre Villa, Pasadena, Calif., the chromatograph is made up of two separate units—the analyzer unit and the control unit. The analyzer unit is housed in an explosion-proof housing for on-stream installation in hazardous areas. It can be provided with precutting, backflushing, multiple-column, and multiple-sample-valve combinations to fit any need. The control unit, which contains all operating controls and adjustments for the entire instrument, can be located on a control panel as far as 500 feet from the analyzer.

The complete analytical process is automatically synchronized by a programming timer system in the control unit. The system regulates the sequence of up to eight streams and times the introduction of samples into the analyzer. An overriding switch permits manual selection of any stream in the cycle. The timer also turns off the recorder between programmed peaks, activates the automatic zero, and attenuates peaks. The attenuation logic board selects only desired peaks for recording. Up to nine components can be selected. Both step and continuous-variable attenuations are provided. Changes in attenuations are made with individual potentiometers on the front panel. Choice of chromatogram or bar chart graph readout is made by a front panel switch.

Circle 427 on Page 19



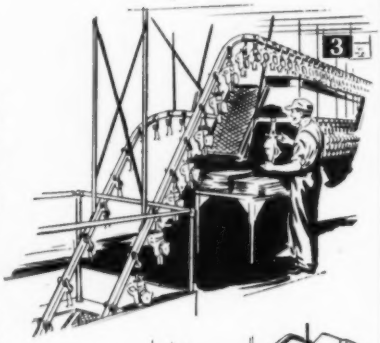

## Load Controller

Designed for use with machines that use ac induction motors for driving power, instrument will continuously measure real load in kilowatts on a drive motor. It indicates the measurement in percentage of rated load from zero to any overload percentage. The controller will operate with single or three phase systems at 110, 220, or 440 volts. It senses both voltage and current and measures the phase angle between them. In the event that the load becomes too great because of tool breakage, etc., a visible or audible alarm is actuated or the machine is shut down

## For Cost-Cutting EFFICIENCY in Any Handling Job... Choose BUSCHMAN CONVEYORS

**PORTABLES...**
**Gravity and Powered...**
**Roller, Wheel, Belt**

Every practical unit is included in the Buschman widely diversified portable line. Identical couplings both ends permit quick assembly of various types into efficient low-cost combinations.



**CABLE...**
**Overhead, Table, Power-Free**

Adaptable to countless operations, they speed production, reduce costs. Universal cable trolley conveyors easily installed from standard, stocked units. Economical, smooth running, durable, efficient.

**COMPLETELY ENGINEERED SYSTEMS**

Buschman utilizes every type of conveyor necessary in planning individual systems to effect most economical, practical handling of materials. Using Buschman plans and their standard stocked parts, your own men can make installations.

Buschman engineering and equipment encompass the entire conveyor field. Our list of users reads like Who's Who in American Industry! This experience can help you write your earnings statement in larger figures. Tell us your problems; let us send pertinent literature and suggestions. The E. W. Buschman Company, 4551 Clifton Avenue, Cincinnati 32, Ohio.

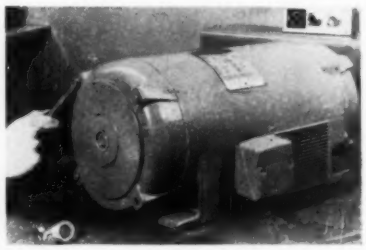
Buschman
CONVEYORS

Complete Conveyor Systems for all Industries—Engineered, Manufactured, Installed.
Representatives in Principal Cities

364


to prevent damage. Fixed loads, such as normal friction in a drive member, can be balanced out if desired so the system will sense only loads that exceed a fixed level. **Seneca Falls Machine Co.**, 23 Fyfe Bldg., Seneca Falls, N. Y.

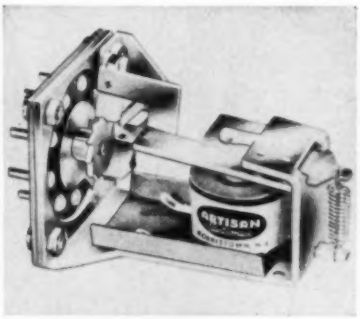
Circle 428 on Page 19



## Adjustable Speed Drives

Line of adjustable-speed ac drives, designated Magnaflow, is rated from 1/4 to 100 hp. The drive is designed to apply adjustable speed power to conveyors, fans and pumps, winders, and metal slitting and forming machines. It can be set before or during operation to deliver any desired speed within its range. A built-in tachometer monitors the output speed and automatically corrects it, regardless of any change in load. Each drive operates on ac power; there are no brushes, commutators, or slip rings to maintain. **Westinghouse Electric Corp.**, P. O. Box 2099, Pittsburgh 30, Pa.

Circle 429 on Page 19




## Stepping Relay

Unit is adaptable for counting and scanning applications. Model CS is available in 2, 3, 4, 5, 6, 9, 10, or 12 position single pole, continu-

*To the Executive caught between Cost and Competition . . .*

# Do you know how much can be saved by using Clad-Rex® vinyl-clad metals?

Here's why you should find out! Products can be fabricated of Clad-Rex with fewer operations than unfinished metals need. What's more . . . the added styling gives them much more sales appeal.

Clad-Rex vinyl-clad metals are "finished" when you get them. Therefore, the extensive metal treating and finishing needed for bare metal is not necessary. Further, the unusual abrasion resistance of Clad-Rex makes delicate handling unnecessary. This sharply reduces rejects, as well as expensive stripping and rework operations.

Clad-Rex vinyl-clad metals can be formed, drawn or worked much the same as bare metals! No special tooling or involved technique is required. Think of the savings you might get handling your raw material from the forming dies directly into assembly!

Incidentally, even though Clad-Rex is prefinished, you're not restricted to the usual limited choice of styling — color, texture and print in Clad-Rex vinyl-clad metals are almost unlimited.

High dielectric strength, corrosion resistance, workability, etc. . . . there's enough advantage that you should get the facts. See for yourself why Clad-Rex, which costs more than *un*finished metals, can make your end product cost less. Write today. No obligation, of course.

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**Telephone: VIctory 2-7272**

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Circle 710 on Page 19

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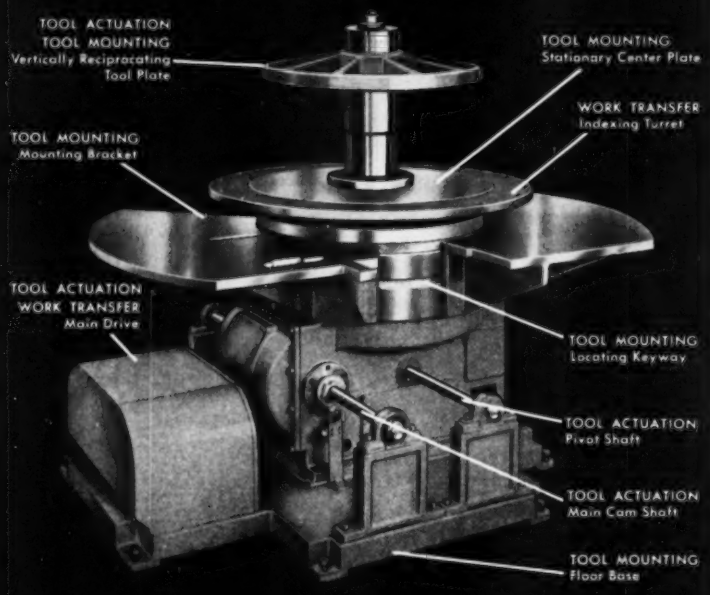


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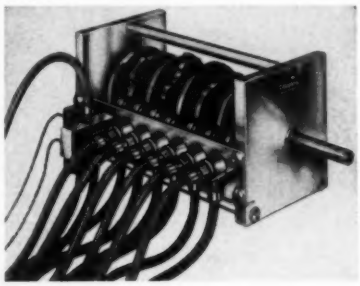
*Designers and Builders of Automatic Assembly and Processing Machines*


ous rotation switching, in either shorting or nonshorting versions. Relay will operate on voltages up to 230 v ac and 110 v dc. Standard contacts will switch 0.25 amp and carry 5 amps. **Artisan Electronics Corp.**, 171 Ridgedale Ave., Morristown, N. J.

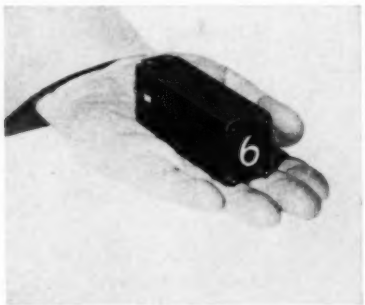
*Circle 430 on Page 19*



## Sequence Programmer

Pneumatic-electrical programming unit is suitable for precise control of automatic tooling and work operations. It can be driven by any power source supplying a minimum of 10 in. lb of torque. Unit is furnished with eight standard cams, but special cams with degree-of-rotation cuts other than standard are also available. Programmer has self-lubricating bearings and the end plates are tapped for mounting to the bottom or rear. **Clippard Instrument Laboratory Inc.**, 7390-P Colerain Rd., Cincinnati 39, Ohio.

*Circle 431 on Page 19*




## Miniature Readout

Miniaturized rear-projection type digital readout can be used with digital computers, control equipment, instruments, and production and inventory controls. The prin-

# Barksdale AIR-SEAL* Valves for the nerve centers of production

** The air pressure is the sealing force; the higher the pressure, the tighter the seal.*

**DIRECT SOLENOID 4-way, 3-way, shut-off and diverter valves**

♦ Standard **AC**

Explosion-proof **AC** ♦

♦ Standard **DC**

Explosion-proof **DC** ♦

**SOLENOID-PILOT 4-way and 3-way valves**

♦ Standard **AC**

♦ Standard **DC**

Explosion-proof **AC** ♦

Explosion-proof **DC** ♦

**MOMENTARY CONTACT solenoid-pilot valves**

♦ Single Solenoid

Both types available in standard AC and DC and explosion-proof AC and DC.

Dual Solenoid ♦

**MANUAL OVERRIDES for standard solenoid-pilot valves**

♦ "L" type manual override

"MK" type manual override ♦

**MANUAL and FOOT OPERATED valves**

Manual 4-way

Manual shut-off

Foot operated 4-way

Write for air valve catalog (AV-9) which contains complete data and prices on 562 different valves (not counting voltage variations).

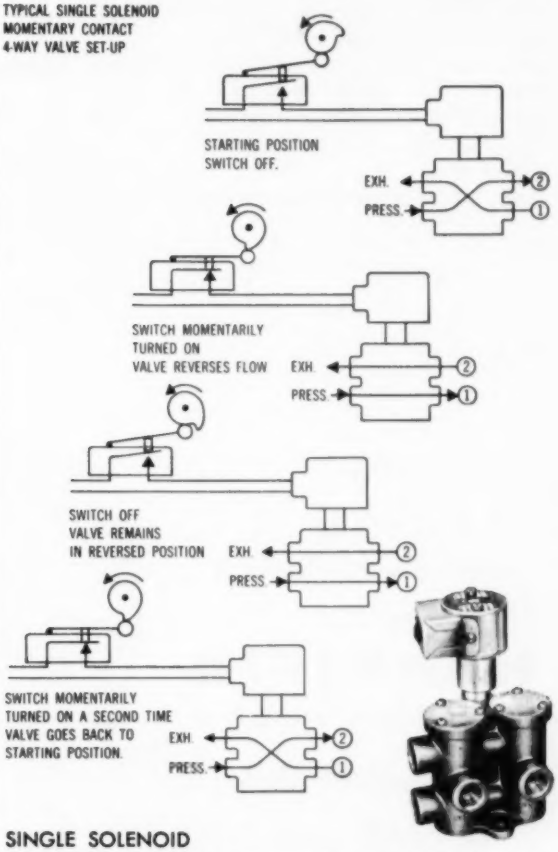
CONTROL VALVE DIVISION

**barksdale valves**

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

# New MOMENTARY CONTACT SOLENOID AIR VALVES

TYPICAL SINGLE SOLENOID MOMENTARY CONTACT 4-WAY VALVE SET-UP




## SINGLE SOLENOID

Current is required only momentarily to change the position of the valve (two-position four-way and three-way valves). When the solenoid is energized the valve is actuated and remains in the actuated position after the current is off. On the next electrical impulse the valve is re-actuated (returned to its former position) and remains in that position with the power off.

## DUAL SOLENOID

Dual solenoids prevent the valve from getting out of phase, particularly important in automated systems. If the same solenoid is energized twice in succession, the position of the valve will not be changed. The opposite solenoid must be energized to reverse the valve. Otherwise the operation is the same as described above for the single solenoid units.

Bulletin 590831 contains complete data.

CONTROL VALVE DIVISION

**barksdale valves**

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

ciple of operation is rear-projection. When one of the twelve lamps at the rear of the unit is lighted, the lamp projects the corresponding digit on the condensing lens through a projection lens onto the viewing screen at the front of the unit. The light source comes from subminiature lamps, either #327, 328, or 330. Voltage is from 6 to 28 v. **Industrial Electronic Engineers Inc.**, 5528 Vineland Ave., North Hollywood, Calif.

*Circle 432 on Page 19*

## Reset Timer

Multiunit reset timer panel can provide automatic control of eight sequential operations. Each timer is calibrated from 0 to 60 seconds with timing ranges up to 10 minutes available. Each set of timers controls a complete operation. The timer in the illustration (Model 8AZC) is controlling operations in a plastic vacuum molding machine. This consists of draping the plastic sheet over the mold, heating and drawing it down with a vacuum action. Two other timers are also available: Model M2ZC for dual timing operations and Model MZC for single operations. **Zenith Electric Co.**, Dept. AN-5, 152 W. Walton St., Chicago 10, Ill.

*Circle 433 on Page 19*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FORCING PRESS

150 TONS to 1 TON

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GAP OR COLUMN TYPES

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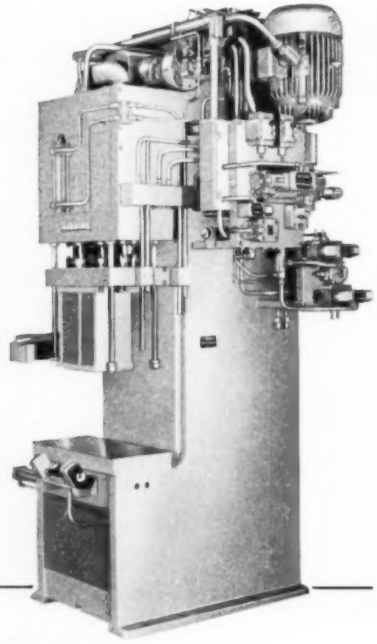
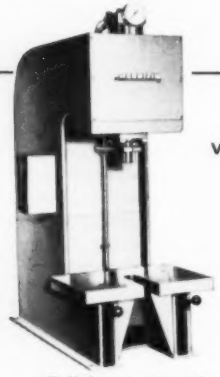




WITH THESE FEATURES:

1. All-steel welded frames—normalized.
2. Steel-head, heavy-duty cylinders.
3. Induction case-hardened rams.
4. Wide choice of ram speeds.
5. Built-in power units.
6. Wide choice of controls.
7. Special loading and unloading mechanisms where needed.

Call in your nearby Hannifin man—he's a trained production analyst—find out how you can do more at lower costs with Hannifin presses. Or, write for our new Bulletin 130-G. It tells the whole story.

**HANNIFIN COMPANY**

541 South Wolf Road • Des Plaines, Illinois

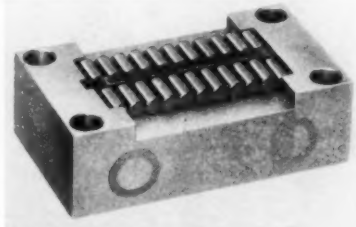
A DIVISION OF PARKER-HANNIFIN CORPORATION

*Circle 713 on Page 19*

## Digital Translator

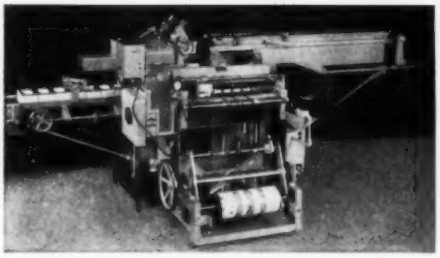
Instrument can accept almost any kind of digital data and provide an analog output plus control signals. Accuracy of the digital-to-analog conversion is 0.1 per cent. Model 42 can be driven by summary punches and card readers, or by mechanical punched tape readers. Translator is supplied with a 10-key serial keyboard for manual input. It accepts 4 digits and sign per axis and provides a front panel display of matrix contents. **F. L. Moseley Co.**, 409 N. Fair Oaks Ave., Pasadena, Calif.

*Circle 434 on Page 19*

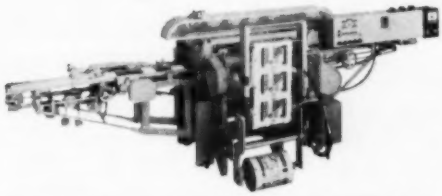


## Roller Way Cartridge

Roller way cartridge is suitable for reducing break-away and drag friction in the operation of machine

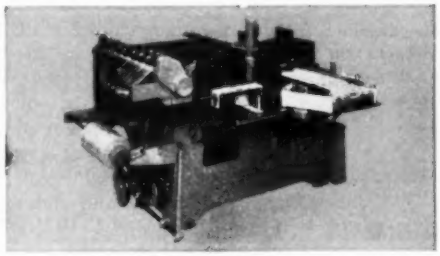


**NOW YOU CAN HAVE TOMORROW'S OVER-WRAPPING MACHINE TODAY!** Battle Creek's completely new Model 475 successfully handles more than 40 different formulations of soft plastic film . . . your assurance new plastic film developments will not outdate this machine. Change of films requires only electronic heat adjustment. Size changes are made in 15 minutes. Wraps up to 75 per minute within 5" to 12" lengths, 3" to 8½" widths and ¼" to 4" heights. Choose any of these films — polyethylene (medium, low and high density 1 mil and up), polystyrenes, heat sealing cellulose acetates, heat sealing foils, polyvinyl chlorides, cellophanes, polypropylenes or polymer coated films. **Battle Creek *"Continuous Flow"* Packaging Machines, Inc., Battle Creek, Michigan.**

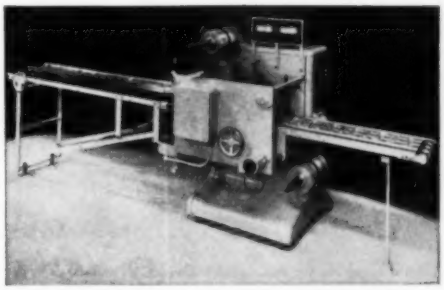


**THE HIGH SPEED MODEL 51 HANDLES A VARIETY OF PACKAGING APPLICATIONS!**

Designed for both speed of operation and wrapping flexibility, Battle Creek's Model 51 is readily adaptable for a wide variety of process-line packaging. Presently used for wrapping such diverse items as candies, soap, cereals, frozen foods, tape, and crackers, this smoothly performing machine operates at speeds up to 200 packages per minute. The Model 51 incorporates an automatic infeed feature allowing it to be timed to previous processing equipment without the necessity of an operator. Adaptable to a wide variety of heat sealing papers, the Model 51 is available in two ranges: 3¼"-5½" for length or 6"-11" length, 2½"-4½" for width and ¾"-2¼" for height. **Battle Creek *"Continuous Flow"* Packaging Machines, Inc., Battle Creek, Mich.**



**REDUCE COSTS... PROTECT PRODUCTS... IMPROVE DISPLAYS... PROMOTE MULTIPLE SALES** with Battle Creek's new Model 850 Automatic Bundler. This machine bundles groups of packages . . . 4, 6, 8, 12 and 24 to a bundle . . . at speeds up to 18 per minute. One operator can easily keep pace with a packaging line as high as 180 per minute. Depending on construction selected, the machine bundles with kraft paper, polyethylene, cellophane and other films; in bundles within 5" to 12" long, 4" to 10" wide and 1" to 8" high. Used for textiles, paper items, drugs, chemicals, cosmetics, food products . . . and/or what have you? **Battle Creek *"Continuous Flow"* Packaging Machines, Inc., Battle Creek, Michigan.**



**CHANGE PACKAGE SIZES WITHOUT EXCESSIVE DOWNTIME!** Handwheel controls for varying the pouch width, and a simple gear change for varying pouch length, — both made without disturbing the heat-sealing units — provide almost instant adjustability. Thin articles (not necessarily uniform in shape) are pouch packaged between two endless strips of heat-sealing packaging materials at speeds up to 80 per minute. Pouch sizes range from a minimum of 2" x 2" x 1/16" to 27" x 15" x 1½" maximum. The "Flexopaker" is especially applicable for articles in the textile, food, automotive parts, industrial products, hardware or similar industries. High speed "Continuous Flow" performance but with a low price tag. **Battle Creek *"Continuous Flow"* Packaging Machines, Inc., Battle Creek, Michigan.**

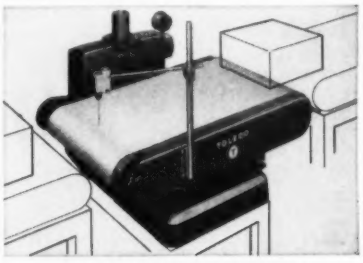
# TOLEDO Reports on Automatic Weighing

★ NEW IDEAS FOR COST-SAVING

*Chance of human error is eliminated in this Toledo system. Each formula is preset on a "Batchboard". The control panel can be located as desired in relation to the scales.*

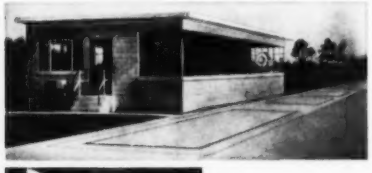
## AUTOMATIC BATCHING

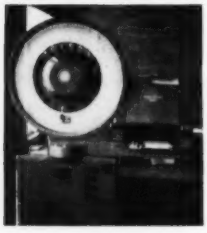
Operator at convenient remote location has full command of a multiple scale batching system with Toledo Remocon. As many formulas as required are pre-set on "Batchboards" and inserted into panel. This is one of several types of Toledo remote-control batching systems for today's needs, including punch card, "Formulaplug" and digital scanner. Ask for Bulletin 2964.



## CHECKWEIGHS IN-MOTION

Many plants today are putting Toledo Automatic Checkweighers into their conveyor lines. Models to provide continuous, 100% in-line checkweighing of items from a few ounces to 200 pounds. Motorized belt. Handle sacks, cartons, packages, pieces, parts. Ask for Bulletin 2968.

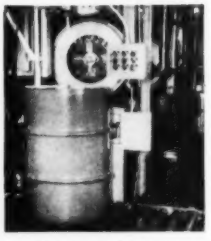




## LOAD CELL DIAL DOES TRIPLE DUTY

**... ALSO PRINTWEIGH RECORDING**

One remote dial serves *three* platforms in this Toledo Electronic Load Cell Scale for truck weighing at a large cement plant. With a truck on three platforms, scale reads individual axle loads or total weight. Equipped with Printweigh "400" to print full figure weight data. Brings new versatility to weighing. Request Bulletin 2970.



## AUTOMATES DRUM-FILLING

In this oil industry plant, a Toledo sub-surface filler automatically eliminates foaming and controls drum filling. The scale is keyed into conveyorized system . . . provides faster, more accurate filling. Saves time, labor, avoids loss of material and customer goodwill. One of many operations where Toledo controls guard costs. Ask for Bulletin 9030.

**WRITE TODAY** for specialized help from our Custom Products Division, or contact the Toledo Office near you, to solve your problems in batching, checkweighing, drum-filling, load cell applications. TOLEDO SCALE, Division of Toledo Scale Corporation, Toledo 12, Ohio.

*(Toledo Scale Co. of Canada, Ltd., Windsor, Ont.)*

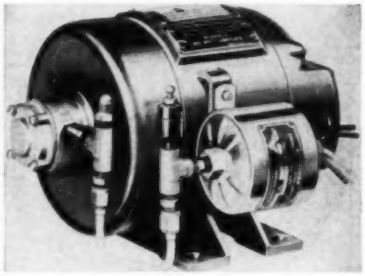
SERVICE Factory-Trained 248 Cities

**TOLEDO®**

*Headquarters for Weighing Systems*


tool heads and tables. End caps of the cartridge are of manganese bronze attached to the bridge by precision rings which are press fitted into annular grooves machined in the end cap and bridge. This method of assembly is said to assure permanent horizontal and vertical alignment of the assembly. It also permits placing the mounting screw holes in the corners of the end caps, providing maximum rigidity of the installation. Races in the end caps are coined and polished, and a drop out slot in the race aligns each roller so it contacts the way square to the line of travel. **Beaver Precision Products Inc.**, Clawson, Mich.

*Circle 435 on Page 19*



## Air Pump

Oil-free air pump is designed for processes or machines which require automatic pressure to 20 psi. The pump has prelubricated bearings, self-lubricating thrust plates and blades, oil free impeller parts, with no seals or shaft packings. A common shaft transmits motor power to the pump rotor and sliding blades. Feature of Model RG10470 is a pressure switch which provides automatic shut-off under increasing pressure conditions at 20 psi and automatic restart under decreasing pressure conditions at 18 psi. An adjustable relief valve maintains safety cracking pressure slightly above cut-off of the air pressure switch, and an integral check valve in the output line prevents loss of pressure when the pump is not operating. Rated pump capacity is 0.3 cfm of free air delivery at 20 psi discharge pressure with standard sea level inlet conditions. Pump displacement is 0.304 cu. in. per revolution. **Lear Inc.**, P. O. Box 688, 110 Ionia N. W., Grand Rapids, Mich.

*Circle 436 on Page 19*

**AUTOMATION TIPS**
by McGill

# CAMROL® bearings...save the cost– and inconvenience–of improvised followers in automated machinery

Why go to the trouble of "building up" special roller followers when CAMROL cam followers can provide so many construction advantages in a standard bearing? Select the proper size from roller diameters of ½" to 4" in either the CF (with stud) or CYR (for shaft mounting). It saves time and money when applying roller followers to cam follower, track, guide and support roller applications.

The McGill construction is backed by over 25 years experience with thousands of applications. Selected steel, tested design, special heat treatment and simplified lubrication insures the dependability of CAMROL — the original roller bearing cam follower.

For protected performance, SCF Series Sealed Camrol Bearings provide the added advantages of better lubrication retention and sealing against dust, dirt and other contamination. Frequent relubrication can be avoided.

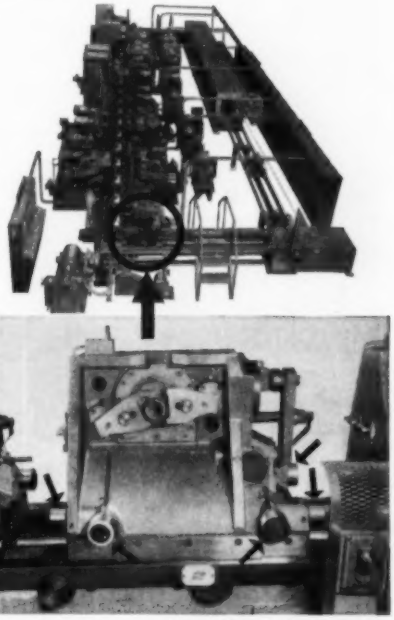
## AUTOMATIC PLATING MACHINES USE CAMROL BEARINGS

CROWN RHEOSTAT AND SUPPLY COMPANY uses up to 200 Sealed CAMROL cam followers as guide and support rollers in the travel and transfer mechanisms of their cleaning, plating and drying machines. The machine shown here is a CROWN Type "D" Fully Automatic Plating Machine. The CAMROL bearings assure precision action, reduced friction and minimum maintenance. Built-in seals protect the bearings from cleaning and plating solutions.

*FOR COMPLETE ENGINEERING DATA ON McGILL PRECISION NEEDLE ROLLER BEARINGS, SEND FOR BEARING CATALOG NO. 52-A*

## FIXTURES ROLL FREE— and accurately on Sealed CAMROL bearings

Production parts are drilled, milled, bored and tapped in automated systems engineered and built by the BUHR MACHINE TOOL COMPANY. The moving fixtures which hold parts being machined are guided and carried on McGill sealed CAMROL bearings as shown in the close-up below.



By reducing the starting and running friction to an absolute minimum, the CAMROL bearings have made horsepower requirement reductions possible in these systems. Ample load capacity, high resistance to shock loads and integral seals which retain lubrication and keep out contamination have held maintenance down. In the system pictured, 8 SCF-3 CAMROL bearings accurately guide and support each of 28 fixtures. Performance is reported excellent.

*engineered electrical products*

**McGILL®**

*precision needle roller bearings*

SEND FOR CATALOG No. 52-A

**MULTIROL — GUIDEROL — CAMROL**

McGILL MANUFACTURING COMPANY, INC., BEARING DIV., 401 N. LAFAYETTE ST., VALPARAISO, INDIANA

AIR-HYDRAULICS INCORPORATED

DOUBLE ACTING • ADJUSTABLE AIR PRESSES

PRECISION HONED WITH CUSHIONED CYLINDERS TWO FAST ACTING MODELS

For fast and steady small assembly work • riveting • punching • marking • staking. Equalized ram pressure in excess of 1 ton and ½ ton from 90 pound line. Double action gives lifting power almost matching ram pressure. Maintenance reduced by using "O" ring seals and bronze ram bushings. Head fully adjusts for proper stroke length and accurate die-setting. Extra heavy ram guide.

FOR LOW COST APPLICATION TO YOUR JOB — WRITE

AIR-HYDRAULICS INCORPORATED

CUSHIONED STOP . . . FOR ACCURATE INDEX

HERE'S YOUR ANSWER, if accuracy and dependability are important to you. Cushioned stop eases work to position. Locking cylinder stops the table "on the money" and holds it until released by locking dog. Changes in loads, diameters or speeds are no problem either, since both speed and cushion are adjustable. Top plate is 15" in diameter but the rugged mechanism will handle much larger work loads. Table will make up to 100 indexes per minute with a 22" diameter, 200 lb. load.

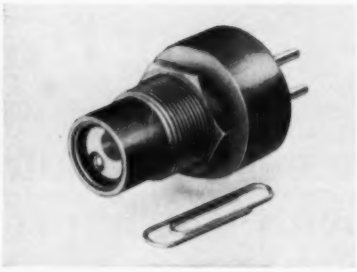
OPERATES on 60-175 lbs. pressure when equipped for air but table is available for either air or hydraulic operation. 4, 6, 8, or 12 stations are standard but others, up to 30, are made to order.

REPRESENTATIVES: SOME TERRITORIES STILL OPEN. WRITE FOR INFORMATION.

AIR-HYDRAULICS INCORPORATED

299 HUPP AVENUE
JACKSON, MICHIGAN

Circle 717 on Page 19



## Photoelectric Scanner

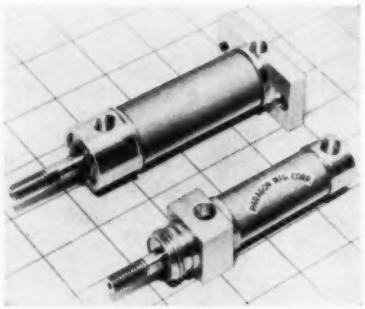
Miniature infrared instrument combines the light-source and photocell in a single unit and operates on reflected light. Model SA-IR will sense metallic and non-metallic objects or control-areas at distances up to two inches. The infrared source is rated at 60,000 hours life when operated at 5 v ac. The solid-state detector is sealed for protection against moisture, dust, or corrosive atmospheres. **Farmer Electric Products Co. Inc.**, 2300 Washington St., Newton Lower Falls, Mass.

Circle 437 on Page 19

## Feed Rate Monitor

Model RF II is designed to monitor the rate of feed of machine tools, utilizing pneumatic or hydraulic actuators. It can be used with automatically controlled linear actuators which require close observation. The indicator can monitor multiple speeds without field calibration or adjustments. Feature of the unit is an automatic reel rewind mechanism which provides positive tracking while the machine is in use. Rapid travel in either direction is possible due to the use of a preloaded spring-driven reel which will track the actual rate of feed. An automatic override is built into the unit to avoid any damage during rapid acceleration. The circuit is protected against variations in line voltage by a regulated power supply. **Digitool Corp.**, 5300 Brownway Dr., Houston 27, Tex.

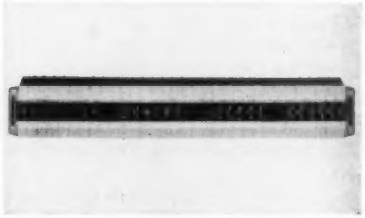
Circle 438 on Page 19



## Fluid Power Cylinder

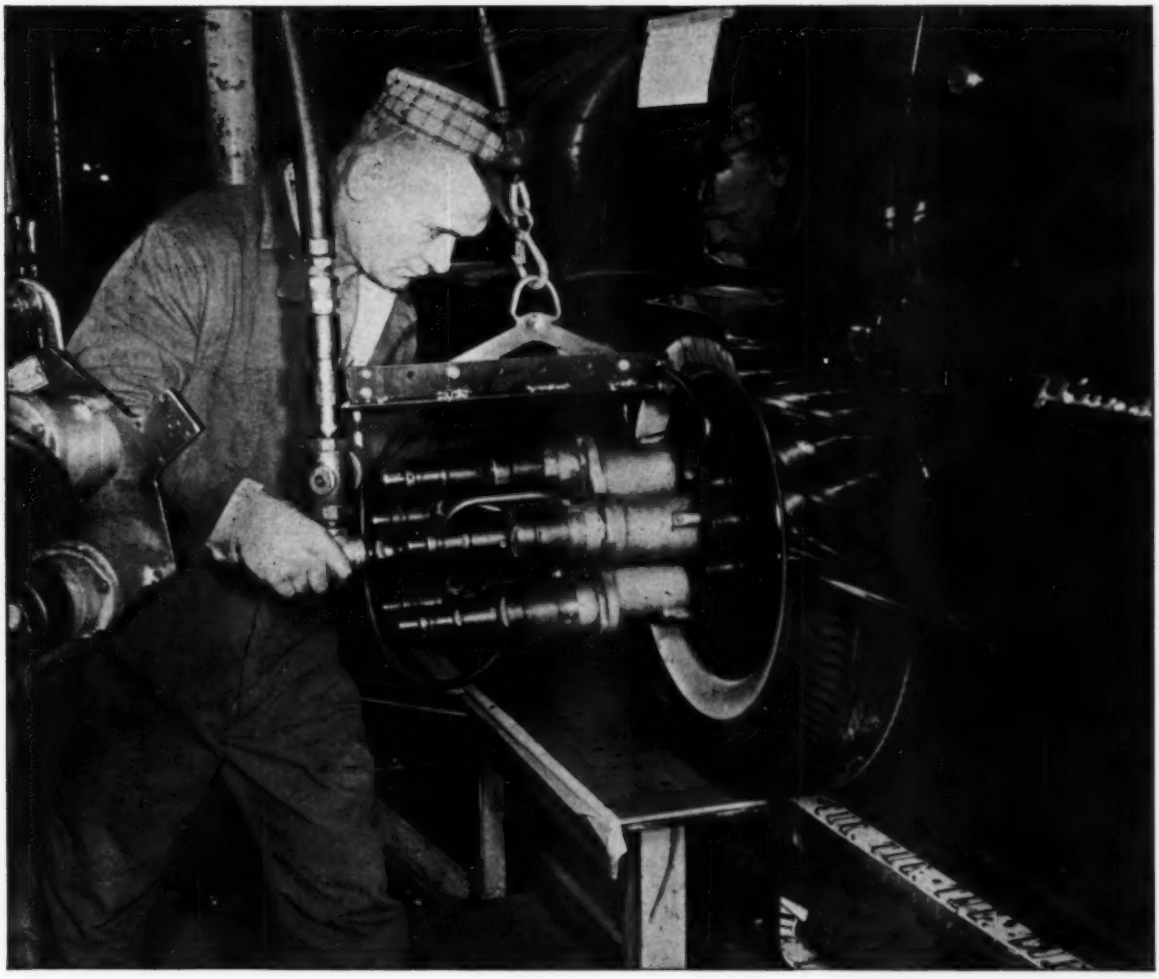
Miniature fluid power cylinder can operate at hydraulic pressures up to 750 psi, and pneumatic pressures to 250 psi. Combination of U-cup packings and honed steel barrel minimizes adhesion between synthetic packings and the metal surface. Heads are permanently attached to the barrel, eliminating the need for tie rods for securing head to barrel. Rod bushings have been eliminated by fabricating the rod head from bronze having good bearing qualities. Valves are available with cylinder diameters of ¾, 1, and 1 3/16 inches. **Paragon Mfg. Corp.**, 1179 E. 134th St., Cleveland 10, Ohio.

Circle 439 on Page 19



## In-Line Switch

Unit is applicable in automatic control systems, computers, and other systems which require the setting of numerical constants or coefficients. The device, designated Digi-



# Touch a button—tighten many nuts at once to precision torque

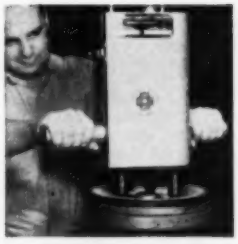
This auto manufacturer tightened down on production costs by automating wheel-nut running. All five are tightened at once with a Gardner-Denver multiple nut setter.

These versatile tools are highly adaptable to a wide variety of time-consuming production jobs. At the touch of a button, nuts of different size, angle or elevation are tightened to precise torque. Tighten two, three, five, twenty or more.

**MODEL CHANGE**

Standardized components make switching from job to job quick and easy. When bolt pattern changes, simply move the standard spindle and handles to a new, job-tailored mounting plate. And Gardner-Denver can also engineer one of its new, adjustable multiple nut setters for you. Here, when your production run includes several similar bolt patterns, you merely push a button to reposition the tool. No change in mounting plate is required.

Find out how Gardner-Denver nut setters, along with a complete line of other production-speeding air tools, may solve tough problems for you . . . lower unit costs. Contact your Gardner-Denver air tool specialist or write for new Bulletin 16-101.



Tighten entire nut clusters in one operation with Gardner-Denver multiple nut setters. Write for further information.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

**GARDNER - DENVER**

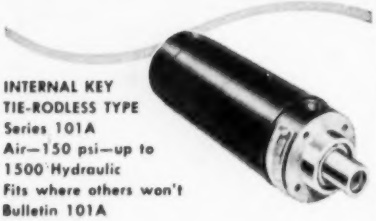
Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

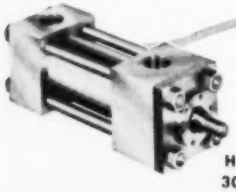


Circle 718 on Page 19

# O-M Cylinders Hold Every Stroke to a Close Tolerance

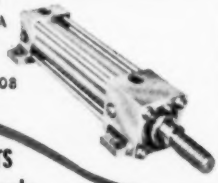


INTERNAL KEY
TIE-RODLESS TYPE
Series 101A
Air—150 psi—up to
1500 Hydraulic
Fits where others won't
Bulletin 101A



IMPROVED
TIE-ROD TYPE
Series 105A
(Heavy Duty)
Hydraulic 2000 psi
3000 psi non-shock
Bulletin 105A

AUTOMATION TYPE
200 psi Air Series RA
1000 psi Hydraulic
Series RH
Bulletins 107 and 108



## all O-M Cylinders meet JIC standards

Regardless of the bore size, diameter of rod, length of rod travel, type of mounting and position in which they are mounted, O-M Cylinders operate with high reliability and precision with every stroke.

Made of all-steel with bearing bronze; these force generating components take shock loads in stride, cushion piston shock and stand up under continuous cycling. In addition, they are sealed right, have the lowest coefficient of friction, make full power starts and require little maintenance.

Available in a complete range of sizes (1½" to 8" bores) with standard or heavy-duty rods. Complete line of mounts and interchangeable parts. Immediate delivery on most sizes. Mail Coupon *NOW* for descriptive Bulletins.

ORTMAN-MILLER MACHINE COMPANY
25 143rd Street, Hammond, Indiana

Send Bulletins
☐ Have representative call ☐ 101A ☐ 107 ☐ 105A ☐ 108

Name_____Position_____
Company_____
Address_____
City_____Zone___State_____

Circle 719 on Page 19

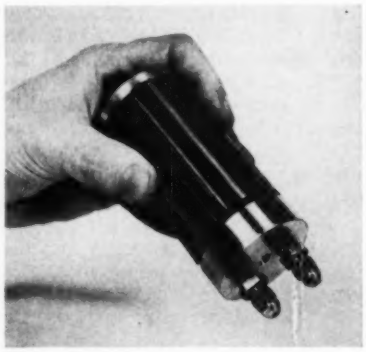

switch, is finger controlled and provides for ten-position, single-pole and double-pole, binary coded decimal with variations, and Octal 0, 1, 2, 4 coded outputs. It is designed in switch modules to permit ganging in any desired number. Internal lighting of the readout and color coding of the switch tabs are also available. **Digitran Co.**, 660 S. Arroyo Parkway, Pasadena, Calif.

Circle 440 on Page 19

## Reed Relay

Resonant reed relay has four channels with frequencies from 315 cps to 405 cps. Sensitivity is 3 mw with a bandwidth of 6 cps. Contact rating is 60 ma at 67½ v. The field coil impedance is 27,000 ohms. Relay has a closure time of 75 milliseconds. **Bramco Inc.**, 4501 Belvidere Ave., Detroit 14, Mich.

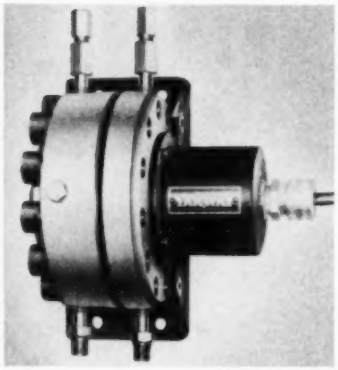
Circle 441 on Page 19



## Flow Control Valve

Device is adaptable for use as a variable damping passage in electro-hydraulic servo systems or wherever needle valves are used for flow control. Rate of flow in Model F4 is linear through 15 turns. Screw adjustment of the length of the viscous passage is of micrometer precision. Since flow adjustment is based on the length of flow passage, the flow passage area is constant. Using Univis 40 oil at a temperature of 115 F and a pressure drop of 100 psi, the flow can be regulated from 10 cc/min to 100 cc/min through 15 turns, equivalent to about 6 cc/min per turn. The flow is further increased to 1150 cc/min through 9 more turns. **Sanders Associates Inc.**, 95 Canal St., Nashua, N. H.

Circle 442 on Page 19



## Pressure Transmitter

Differential pressure transmitter can control a distant indicator, controller, or other electrically-operated receiving instrument. The transmitter consists of a diaphragm mechanism in a pressure housing with pressure connections at the bottom, and a sensing coil which operates the remote receiver. The sensing coil is protected by a weatherproof cover. Cable connection to the receiver is at the right end of this cover. The unit can be mounted at any location. It is connected to the liquid vessel, fluid line, or other container by two tubes. At the transmitter, the tube connections lead to the opposite side of the diaphragm. Variations in the differential pressure on the diaphragm cause changes in the output of the sensing coil which is transmitted to the remote receiver. **Yarnall-Waring Co.**, 102 E. Mermaid Lane, Philadelphia 18, Pa.

Circle 443 on Page 19

Detroit
JOrdan 6-4767

Toronto
Ajax 1395

Cleveland
ACademy 1-6440

Chicago
COlumbus 1-7199

Youngstown
STerling 8-9661

Seattle
MUtual 1997

Cincinnati
TRinity 1-2520
and
EAst 1-8844

San Francisco
JUno 9-3050

we like to be close
to our customers

Erie
GLendale 5-9604

Los Angeles
LUdlow 9-3453
and
ANgeles 9-7304

New Haven
MAine 4-2375

Denver
BElmont 3-2333

and future customers!

Philadelphia
GArfield 6-6520

Houston
PArkview 3-3521

Atlanta
TRinity 5-8196
and
CEdar 3-2361

Nashville
CYpress 2-7016

Trenton
OWen 5-6205

Whether you want information on an application, or service on an existing installation, the Ajax Magnethermic man can give you assistance. He knows induction heating and melting.

*induction heating is our only business!*

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GENERAL OFFICES.....P. O. BOX 839
Youngstown 1, Ohio

TRENTON DIVISION.....930 Lower Ferry Road
Trenton 5, New Jersey

YOUNGSTOWN DIVISION...3990 Simon Road
Youngstown 1, Ohio




Circle 720 on Page 19

DeVilbiss spray guns apply almost anything that pours — automatically!

# Spray lubrication

DeVilbiss WDB automatic spray guns are specially designed for cycled or continuous application of lubricating oils and drawing compounds during metal forming operations. Guns are adjustable for spray-pattern size, shape, and fluid volume. Apply measured amount of materials exactly where needed. Instant-acting pneumatic control provides up to 90 spray cycles per minute. Call our nearest representative. The DeVilbiss Company, Toledo 1, Ohio. Branch offices in principal cities.

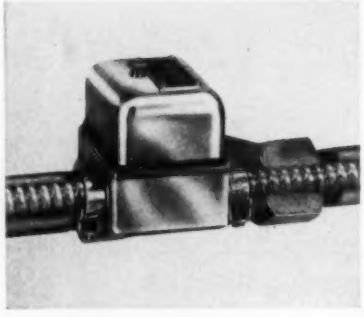
FOR TOTAL SERVICE, CALL
DEVILBISS

Circle 721 on Page 19

## Arc Inhibitor

Unit is designed for use with dc crane and mill controllers which are operated by master switches or pendant pushbutton stations. Inhibitor suppresses arcs and absorbs voltage surges to keep voltage rise within safe limits. The units are recommended for 115 and 235 v dc inductive circuits, are connected in parallel across the coil terminals of magnetic contactors. Vital components are embedded in an epoxy resin compound for protection against dust and moisture. **EC & M Div., Square D Co.**, 4500 Lee Rd., Cleveland 28, Ohio.

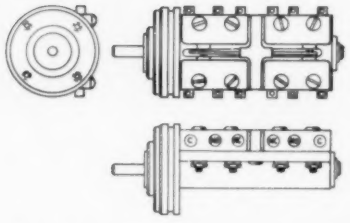
Circle 444 on Page 19



## Motor Control

Fluid flow motor control is designed as a pumping unit protection switch. It can protect hydraulic systems that have components which depend on minimum fluid flow rate for lubrication or cooling. Feature of the control is the time delay switch which allows fluid to start up and attain normal flow rate before taking over control of the electrical circuit. Model 27 has a maximum working pressure of 100 psi, with a maximum of 12.5 gpm and a minimum of 0.33 gpm. It can be mounted in any position anywhere in the pump pressure line. **Payne Engineering Co.**, Pine Hall, N. C.

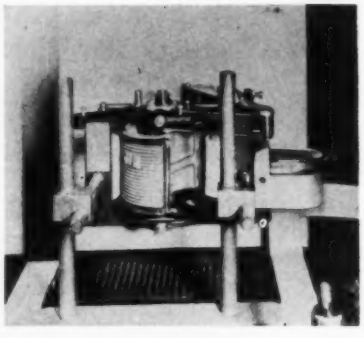
Circle 445 on Page 19



## Subminiature Limit Switch

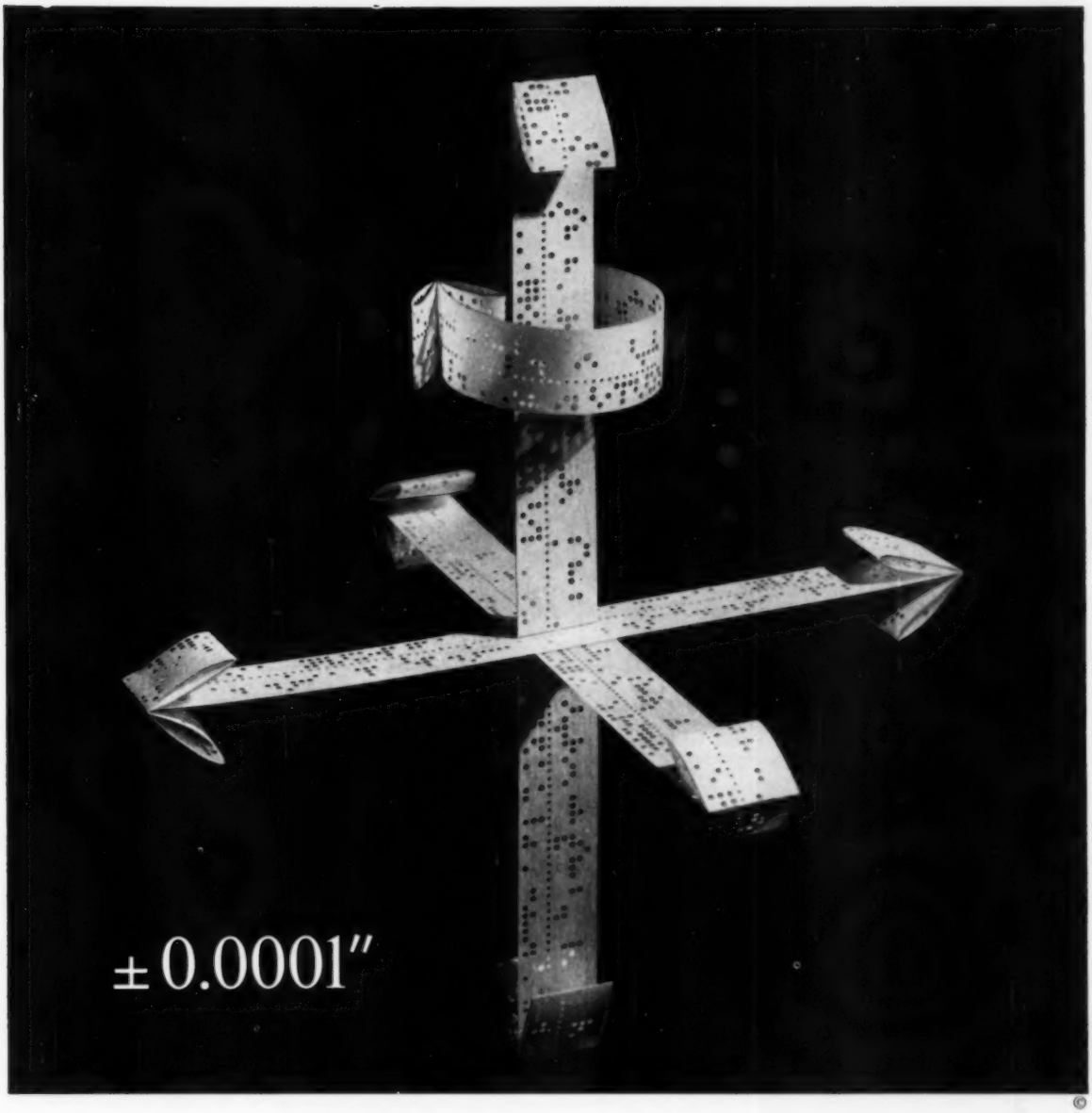
Device is applicable where a fixed number of revolutions or fractions thereof of rotating shafts are required. An example is servo mechanisms in which mechanical stop protection is required as well as actuation of electrical switches at each end of the preset limit. Model SLS-2 supports four limit switches. Two limit switches are mounted at each end of the slide bar, facing one another. Presetting of the slide bar and positioning of the switches results in one switch being normally closed, the other normally open. When a pinion reaches the stop collar, further shaft rotation deflects the slide bar to actuate both switches on that end. **Arch Instrument Co. Inc.**, 101 Holmes St., North Quincy 71, Mass.

Circle 446 on Page 19



## Conveyor Marker

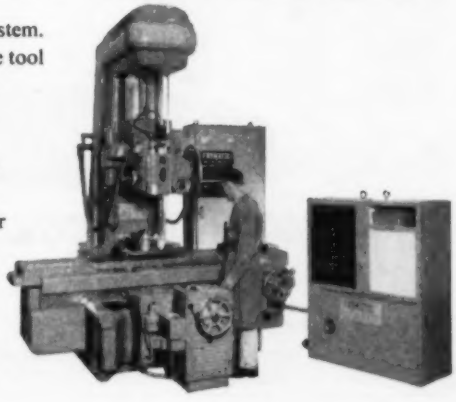
Unit can print on mixed carton sizes in the same run, holding per-




# **PRECISION BORING:** Control gains a Third Dimension!

Now Fosdick adds Numerical Depth Control to its unique positioning system. Another loophole for error in precision boring has disappeared. Watch the tool drive smoothly to depth, boring a hole with finer finish, precise in depth and location. Watch the tool advance and retract quickly, saving time. *Tape or dial any depth. Absolutely no stops to preset.*

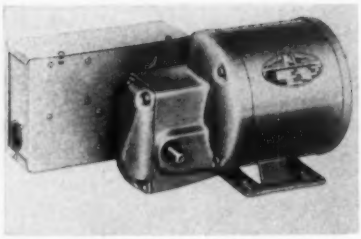
See how this control signals every tool change and compensates for tools of random length. It was planned when the Fosmatic precision boring machines were designed, so that it fits and takes no extra space. Consider what this new dimension in control means to your critical production jobs. Write for catalog PB-W.



FOSDICK THE FOSDICK MACHINE TOOL COMPANY
Cincinnati 23, Ohio

fect registration and accurate marking throughout the run. It can also be used in conjunction with a production counter, with cartons marked and counted in one operation. The unit mounts on the top, bottom, or either side of a conveyor, or in a case sealer. A swivel-action cylinder provides positive, even pressure. Marker has an automatic capillary ink feed. **Algene Marking Equipment Co.**, 232 Palisade Ave., Garfield, N. J.

*Circle 447 on Page 19*

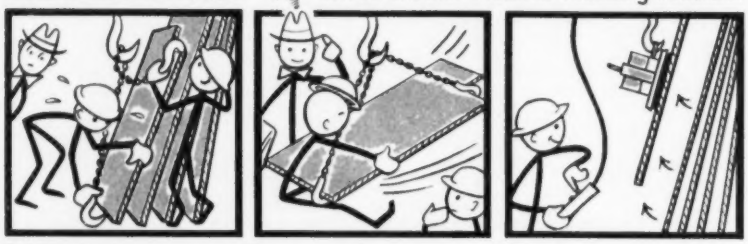


## Reversing Gear Motor

Instant-reversing geared motor is controlled by built-in adjustable limit switches. It features an automatic safety device which instantly reverses the motor rotation whenever a predetermined resistant force is encountered by the driven product. The degree of resistance wanted to actuate this switch is adjustable, the instant-reversing, full-power torque of the motor is applied instantly whenever the switch is actuated. The motor is applicable for imparting automatic control to indexing, conveying, and tool operations. Motors are available from 1/6 through 1 hp, with ratios of 20:1 through 30:1, with gear reduction in the motor end bell. **Franklin Electric Co. Inc.**, Bluffton, Ind.

*Circle 448 on Page 19*

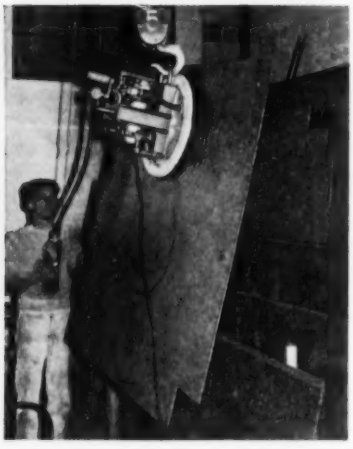

**VAC-U-LIFT VAN** Solves another Material Handling Problem!



**1** STEEL PLATE—the way we're handling it today, the bigger and heavier it is, the more men we need, 2, 3 or even more.

**2** Dangerous too, but in a few seconds VAC-U-LIFT Van knew his compact PAD-PAC could do a safer, better, and more economical job.

**3** Now it's a breeze with VAC-U-LIFT PAD-PAC—and a real management bonus—one man can perform the complete operation.



**SINGLE PAD-PAC**

New, versatile VAC-U-LIFT PAD-PAC has been especially developed for scores of in-plant material handling operations. Use in vertical or horizontal position. Not limited to specific industries. Handle steel plate, glass, stone, concrete, barrels and many other non-porous materials. Let VAC-U-LIFT prove that vacuum handling is safe, fast and economical. Get in touch with your VAC-U-LIFT representative. Let him tell you how vacuum can help you with your material handling.

*All VAC-U-LIFT units carry a full 3 month unconditional warranty.*

**VAC-U-LIFT**

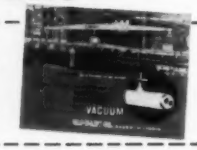
**HAS THE SOLUTION!**

*Send Today For FREE Illustrated Brochure*

This brochure shows some of the many VAC-U-LIFT systems now in use. It explains how VAC-U-LIFT works and how you can take advantage of VAC-U-LIFT'S 3-step analyzation service without cost or obligation, write

**DEPT. VL-99, VAC-U-LIFT CO., Salem, Illinois**

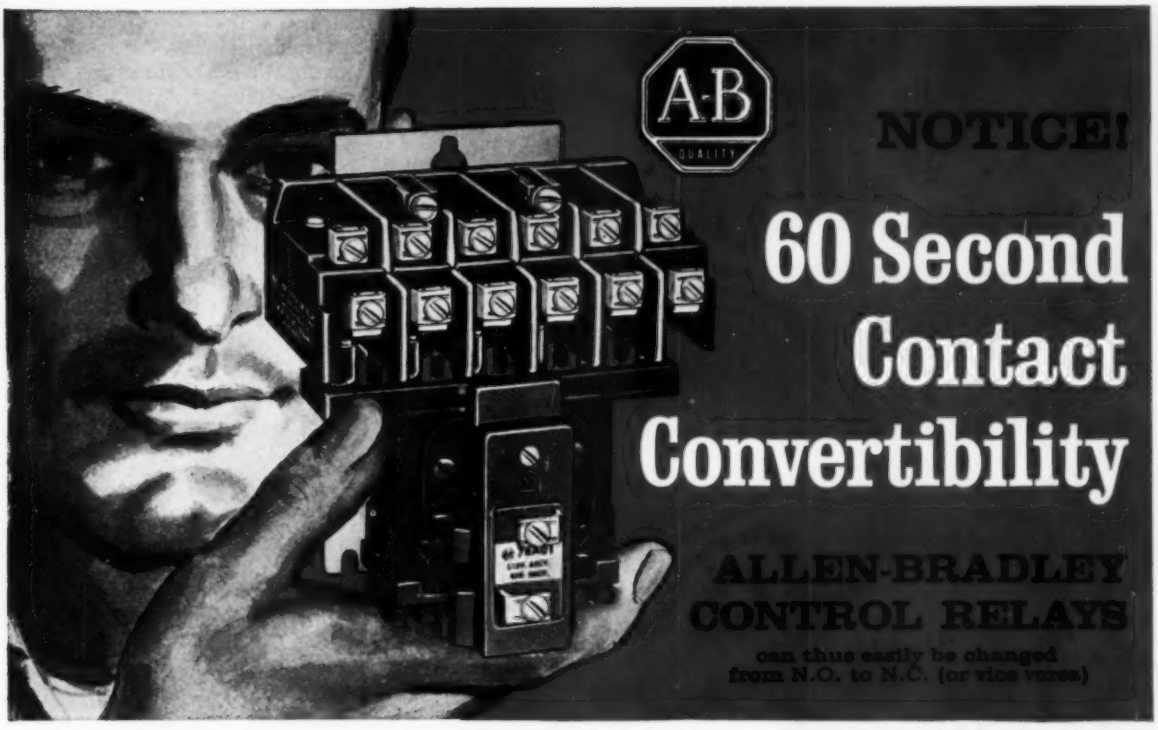
*Division of the Siegler Corporation*



## Limit Switch

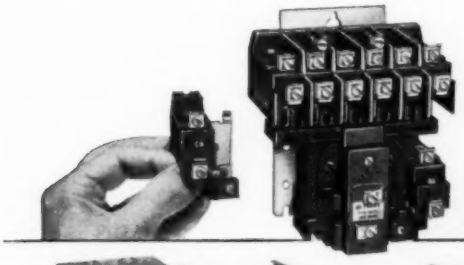
Designed for application on high-speed, precision production machines, limit switch is sealed to check seepage of oil, coolants, moisture, and abrasive grit. External seals are located at the operating shaft bearing and between the cover plate and contact assembly. An internal seal between the operating head and switch base protects the contact cavity against the entrance of liquids. The switch is available in both surface type and flush type mountings. It is calibrated to control tolerance producing identical operation of all switches. Fourteen different operating heads are available and they can be mounted in any of four positions, 90 degrees apart. Rotary levers can be positioned anywhere through a 360 degree circle. **Cutler-Hammer Inc.**, 378 N. 12th St., Milwaukee, Wis.

*Circle 449 on Page 19*



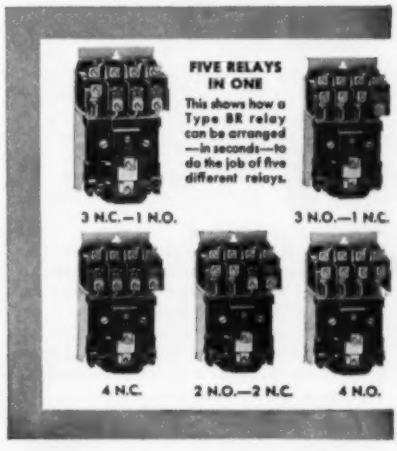

Why not give yourself a real surprise! We refer to the ease with which you can convert the contacts of these Allen-Bradley Bulletin 700 Type BR control relays. Using only a screwdriver, contacts can be changed from normally open to normally closed (or vice versa) in seconds—without removing the relay from its mounting—or its wiring. This "on-the-spot" convertibility certainly suggests an appreciable moneysaving reduction in your relay inventories.

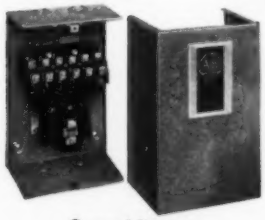
Extensive tests have proven conclusively that the Bulletin 700 Type BR relays are good for many—and we mean *many*—millions of trouble free operations. A "built-in" permanent air gap completely eliminates all possibility of magnetic sticking. Naturally, the double break, silver contacts never need attention. Also, the molded coil is your assurance that even the most severe atmospheric conditions cannot cause trouble. Please write for full details on these relays today!



**BUT HEAR THIS!**

In the event that when "on-the-job" it is discovered that something was either overlooked or added, the standard Bulletin 700 Type BR—either 2, 4, or 6 pole relay—can easily have added to its base, out in the field, either one or two switching poles. It is done as easily as "falling off a log."


FIVE RELAYS
IN ONE
This shows how a Type BR relay can be arranged —in seconds—to do the job of five different relays.
3 N.C.—1 N.O.
3 N.O.—1 N.C.
4 N.C.
2 N.O.—2 N.C.
4 N.O.



General-Purpose
NEMA 1

Explosion-proof
NEMA 7

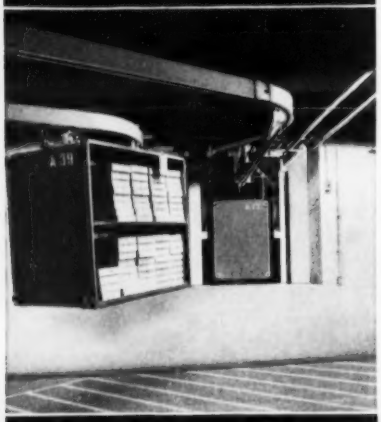
Waterproof
NEMA 4

**ALLEN-BRADLEY**
Member of NEMA

**QUALITY MOTOR CONTROL**

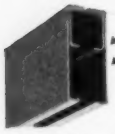
# Power -Flex

POWER AND FREE
OVERHEAD CONVEYOR SYSTEM*



WITH TELEMATIC
AUTOMATIC DISPATCH CONTROL

• *Simply set dials and Telematic guides carrier to any station in system*




Employs exclusive unitized "over and under" power and free rail which permits simple switching to right or left as desired.

Power-Flex is designed for automated materials forwarding applications in industrial plants, distribution centers, service buildings and department stores. The most economical system available for loads up to 600 lbs. per carrier. Savings in actual installations range from 25% to 60%.

*Systems in service for your inspection.

*Engineered to your very specific requirements.*

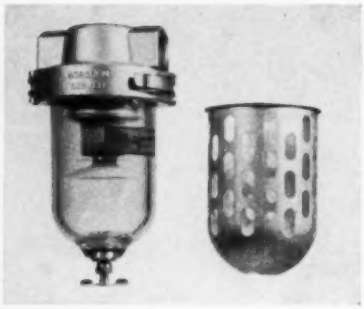
SEND FOR BROCHURE

*Inquiries from your engineers or consultants welcomed.*

CM CONVEYORS

COLUMBUS McKINNON CHAIN CORPORATION
*Conveyor Division*
TONAWANDA, N. Y.

*Circle 725 on Page 19*

## Air-Line Filter

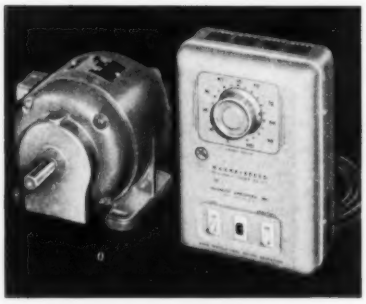
Air-line filter is capable of removing all of the liquid present in compressed air over the full range of air-flow capacity of the air line. Feature of the unit is the transparent bowl, made of plastic. It has a higher safety factor and a greater resistance to fatigue under cycling loads. Metal bowl filters are also available. Both bowls can be used with ¼, ⅜, and ½-inch pipe sizes. With only four parts to handle, the filter can be quickly taken apart and easily cleaned. A choice of four interchangeable filter elements is furnished for removing the solid particles such as grit, dust, pipe scale, and rust. **C. A. Norgren Co.**, 3400 S. Elati St., Englewood, Colo.

*Circle 450 on Page 19*

## Rotary Sensing Unit

Instrument is suitable for a wide range of bidirectional measuring and control applications, such as machine tool positioning for precision cutting-to-length, welder electrode positioning, drilling, and coilwinding. Measuring wheels can be connected to the shaft of the add-subtract Rotopulser (Model 82) to convert forward and backward mechanical motion into corresponding electrical pulses—up to 120 counts per rotation, in either direction. These positive or negative pulses are then fed to remote digital reversible counters, controllers, or readout devices. In length measuring applications, the unit eliminates errors where vibration conditions are encountered, and also compensates for backlash. **Dynapar Corp.**, 7312 N. Ridgeway Ave., Skokie, Ill.

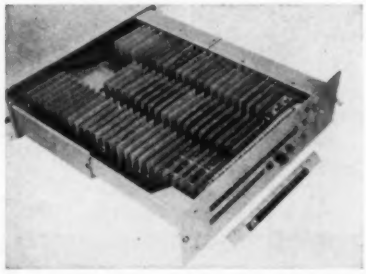
*Circle 451 on Page 19*



## Variable Speed Drive

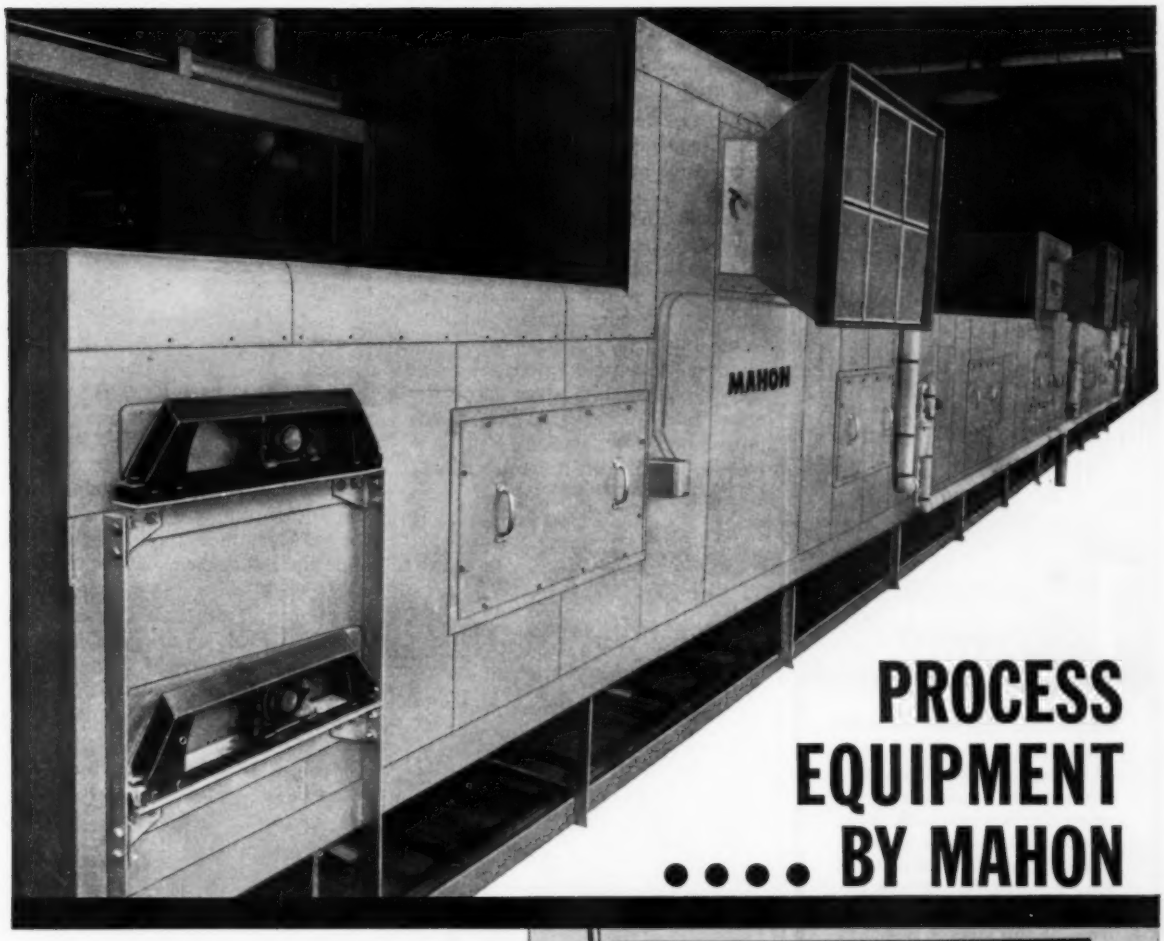
Unit provides adjustable dc voltage for driving dc shunt motors. It will operate from 115 v, 60 cps, single phase supply. Drive is available in three sizes: Junior for 1/100 to ⅛ hp motors, Size I for ¼, 1/3, and ½ hp motors, and Size II for ¾, 1, and 1½ hp motors. Regulation is approximately ±4 per cent of base speed, speed range to 50:1, instantaneous response, with vernier speed adjustment. **Magnetic Amplifiers Inc.**, 632 Tinton Ave., New York 55, N. Y.

*Circle 452 on Page 19*



## Core Memory Tester

Solid-state magnetic core memory tester will check the accuracy of an



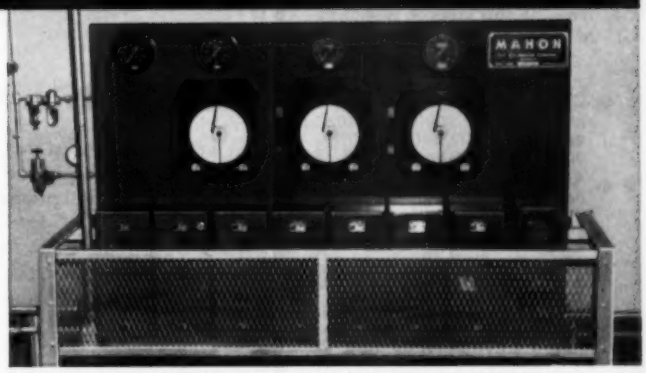

# PROCESS EQUIPMENT .... BY MAHON

## new plastic-curing oven system for GOODYEAR is double-decked for efficiency

Curing of 75-ft. long, 7-ft. wide sections of a spongy plastic material, with heating and cooling cycles rigidly controlled, is a tough processing problem. Mahon equipment does the job two-at-a-time . . . and also automates the method! This new oven system converted the operation to a smooth, continuous process.

The unusual installation (shown above) is 80-ft. long with double-decked ovens for increased capacity. Specially developed by Mahon and Goodyear engineers, the system features integrated materials handling, precisely controlled heating and rapid cooling. Curing is done at preset temperatures up to 300°F, the ovens holding the plastic sections for about eight hours. At the end of this cycle, the entire system is fast cooled, the work discharged and the ovens brought back up to heat—all automatically.

If you are considering new or improved process equipment call in a Mahon engineer . . . their assistance could prove invaluable.




Special oven control panel, designed by Mahon for the Goodyear Tire and Rubber Co., monitors the entire eight-hour curing cycle for the plastic material.

**Write for Descriptive Catalog A-660 on the scope of Mahon Industrial Equipment for metal finishing, cleaning, painting, heating, heat treating, etc. Also in Sweet's Plant Engineering File.**

**THE R. C. MAHON COMPANY**
*Detroit 34, Michigan*

YOUR BIGGEST VALUE is in MAHON'S planning and engineering EXPERIENCE

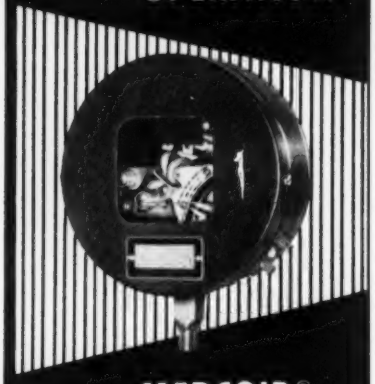
Manufacturing Plants—Detroit, Mich. and Los Angeles, Calif.
Sales-Engineering Offices in Detroit, New York, Chicago, Los Angeles and San Francisco
Representatives in all principal cities

# M A H O N



Circle 726 on Page 19

2 STAGE CONTROL OPERATION



1 MERCOID® PRESSURE CONTROL

**MERCOID DA-400 SERIES**

Pressure Controls are dual purpose controls, incorporating a single pressure element operating two separate, independently adjustable Mercoid magnetic switches. The switches may be used for multiple circuit control for various operations as the control responds to pressure changes.

For example:

- Close one alarm circuit at high pressure and another at low pressure with both circuits open over operating range.
- As an electrical interlock to open one circuit as pressure rises above and the second circuit as the pressure drops below operating range.
- To provide two-stage control by opening or closing one circuit on a rise in pressure and the second circuit on a further rise in pressure.

**AVAILABLE IN 17 PRESSURE RANGES**

**0-30″ VAC. TO 300-2500 PSI.**

**Available in three case styles:**
**General Purpose (NEMA 1)**
**Weather-Proof (NEMA 1A, 2, 3, 4)**
**Explosion-Proof (NEMA 7, 9)**

**WRITE FOR BULLETIN NO. 11**

THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.

*Circle 727 on Page 19*

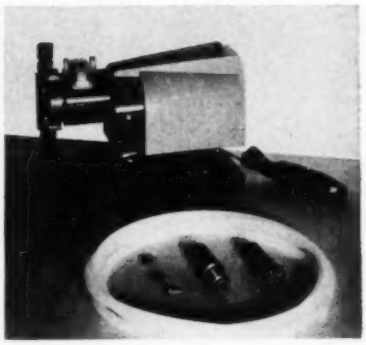
address core memory. The tester will fit a standard relay rack, will operate on 105 to 125 v ac, 50/60 cps. The core memory test can be made on selected addresses and bits or in sequence on all addresses with every combination of 19-bits. During the test, it is possible to start, stop, or restart from any address with any word pattern. Register indicators on the front panel show each 19-bit word written in or read out and the relevant memory address. When an error is detected in the memory, the tester stops immediately and the indicators show the error source. **Packard Bell Computer Corp., Div., Packard Bell Electronics,** 12333 W. Olympic Blvd., Los Angeles 64, Calif.

*Circle 453 on Page 19*

## Transistor Drive Module

Transistor drive module is designed for the Nixie indicator tube. The module, designated Trixie, is comprised of ten medium-voltage transistors in a common emitter configuration with each transistor driving one of the indicator tube's ten cathodes. The circuit is designed to take advantage of the transistors operating in a break-down condition where the current is limited by the indicator tube. This results in negligible current being drawn by the nine *Off* cathodes and prevents damage to the transistor junction. The readout modules can be triggered by signals as low as 3 v, requiring currents of only 300 microamperes. The unit is recommended for temperatures of −30 to +55 C. **Electronic Tube Div., Burroughs Corp.,** P. O. Box 1266, Plainfield, N. J.

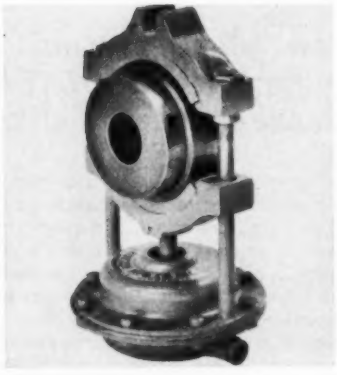
*Circle 454 on Page 19*



## Proportioning Pump

Instrument can accurately proportion concentrated corrosive chemicals such as 66 degree Baume sulfuric acid, sodium hydroxide, phosphoric acid, photographic solutions, and hydrofluosilicic acid. Model 1331 consists of a pump, foot valve, injection nozzle, and connecting hoses. Stroke length of the electrically-driven pump is adjustable while in motion; range of the unit is over 4:1 with a capacity up to 0.7 gph into discharge pressures up to 100 psig. **B-I-F Industries Inc.,** 345 Harris Ave., Providence 1, R. I.

*Circle 455 on Page 19*



## Diaphragm Brake

Unit provides accurate tension control for operations requiring 1600 in.-lb of torque or less. It is applicable for unwinding stands of small cutters, sheeters, slitters, converting or printing machines, running foil, film, or light weight paper stock, or wherever a constant, slight, or intermittent drag is needed to prevent overrunning. The brake is self-adjusting for wear, is equipped

CHOICE OF BUILT-IN VALVES GIVES CONTROL FLEXIBILITY

SINGLE AIR CONNECTION SIMPLIFIES INSTALLATION

RUGGED CONSTRUCTION ASSURES LONG LIFE

160 BELLOWS SALES AND SERVICE FIELD ENGINEERS

■ There are one or more Bellows-Valvair Field Engineers in every industrial area of the United States and Canada. They will be happy to work with you in applying "Controlled-Air-Power" to your machine designs. They are listed in their local phone directories both under "The Bellows Co." and "Valvair Corp."

7588-3

# Four reasons why THE BELLOWS AIR MOTOR® stands first with tool engineers

In designing for air cylinder operation the engineer wants first of all sure, positive control, easily interlocked to related machine movements. **He has it in The Bellows Air Motor.**

He wants simple installation, uncomplicated by cumbersome piping. **He has it in The Bellows Air Motor.**

He wants rugged construction — an air cylinder that will stand up day in and day out with minimum requirements for service and repairs. **He has it in The Bellows Air Motor.**

But he also wants the knowledge, if service should ever be needed, that it is quickly available wherever his machine may go. **He has it in The Bellows Air Motor.**

This free booklet offers interesting data for the tool engineer. Write for it today. Address Dept. AU-560. Ask for Bulletin BM-25. Bellows-Valvair, Akron 9, Ohio. In Canada: Bellows-Valvair, Ltd., Toronto 18, Ont.

**Bellows-Valvair**

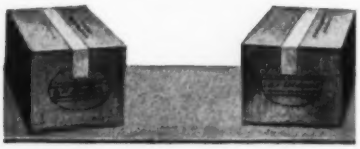
*The Bellows Co. • Valvair Corp. Akron 9, Ohio*

DIVISIONS OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)



Circle 728 on Page 19

## For on-the-line package weight control — W-C CHECK-WEIGHING SYSTEMS



Whatever your requirements for production check-weighing of packaged materials, W-C can supply a job-engineered system to meet them. Systems can be automatic or manual; can weigh in motion or stop-and-go; can segregate packages according to specific zones of under- or overweight, or according to a single pre-selected tolerance. They can provide practically any type of readout you want, and can be readily integrated with tape-fed, punched-card and other types of data handling systems.

Surprisingly, such job-engineered systems can be delivered at a most realistic cost—probably less than you'd expect. The reason why is a simple one: pre-engineered components, unitized design. There is no speculation or experimentation; W-C systems are designed on the very practical basis of service-proven, standardized components.

**Typical applications include:** Checking weight of tire treads as extruded . . . checking container weights after automatic filling . . . checking multi-unit package weights.

Write for new Bulletin 50

W-C

WEIGHING & CONTROL COMPONENTS, INC.
Div. of CompuDyne Corp.
E. County Line Road • Hatboro 12, Pa.
B.A. 2124

Circle 729 on Page 19

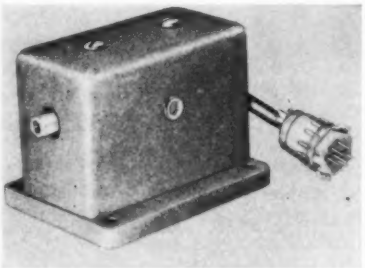

with linings that can withstand high speeds. Air diaphragm of the unit has a ¾-inch stroke. **Horton Mfg. Co. Inc.**, 1179 15th Ave. S. E., Minneapolis 14, Minn.

Circle 456 on Page 19

## Beam Switching Tube

With the use of a beam switching tube, supply voltages can be utilized from 300 v for operation in conventional tube circuits, to below 28 v for transistor circuits. A single cathode provides an electron beam for any one of ten constant current outputs, and switching between outputs is achieved by a wide variety of wave forms supplied to switching grids. In the device, designated Trochotron, an electron is made to travel along equipotential lines under the influence of crossed electric and magnetic fields to a series of stable positions, with very fast switching rates. **Baird-Atomic Inc.**, 33 University Rd., Cambridge 38, Mass.

Circle 457 on Page 19



## Displacement Detector

Position-sensitive transducer is suitable for a wide variety of remote detection applications including the measurement of beam deflection, thickness, strain and elongation, surface quality of materials in motion, and thermal expansion of metals. Model DP-33 incorporates a linear variable differential transformer as the basic sensing element and features high stepless output, external zero adjustment, and infinite resolution. It will operate over a temperature range from −65 to +220 F. Special units are available for operation in environments up to 500 F. Output voltage for nominal 6.3 v input ranges from 0.250 at 60 cps to 1.6 at 20,000 cps. **Schaevitz Engineering**, P. O. Box 505, Camden, N. J.

Circle 458 on Page 19

## Wire Cloth Filter

Hydraulic suction device filters out dirt, grit, pipe scale, and other impurities which cause pump and valve failures, scored cylinders, and over heating in hydraulic systems. The filter element provides approximately 10 square inches of filtering area for each rated gallon of flow. At rated flows with 220 SSU mineral base oil, the pressure drop is 0.5 psi or less. Filter can be cleaned with solvents or backwashing. **Arrow Tools Inc.**, 1972 S. Kostner Ave., Chicago 23, Ill.

Circle 459 on Page 19

## Relief Valve

Flange type valve is designed for bypass oil relief service. It is available in three styles. Model HFC-9 is a 2½-inch valve for 325 lb maximum pressure. It uses a pilot-type operation with two pistons and two

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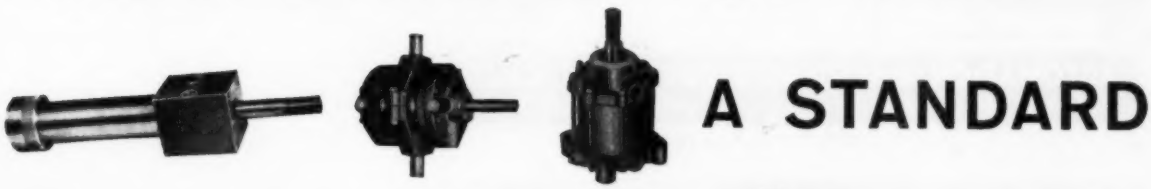
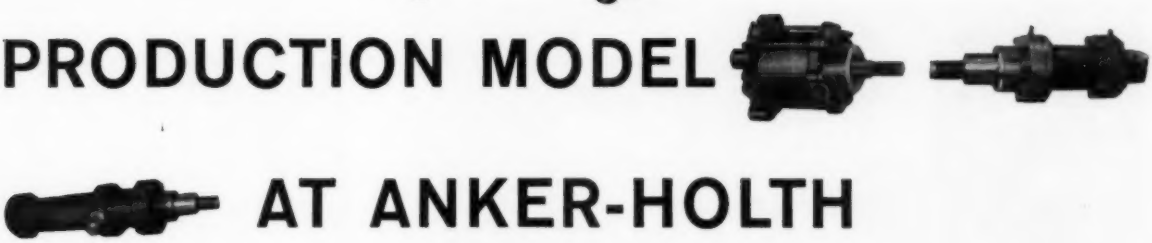
# OF FINDING THE EXACT POWER CYLINDER YOU NEED IN



# A STANDARD PRODUCTION MODEL



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Anker-Holth makes the world's widest selection of standard power cylinders. That means that you have a better chance of finding the exact cylinder when you call on us for your power needs. Anker-Holth standard cylinders, built to JIC specifications with bores of 1 to 30 inches and strokes to 40 feet, are time-tested and experience-proved in every major industry. Nine complete lines are offered and all mountings are available.

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ANKER-HOLTH DIVISION
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Name_____

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AMECO

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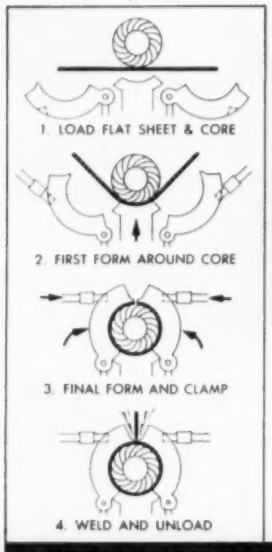
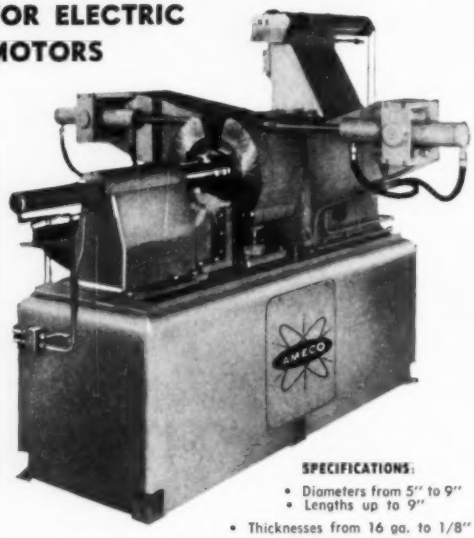
FOR ELECTRIC MOTORS




SPECIFICATIONS:

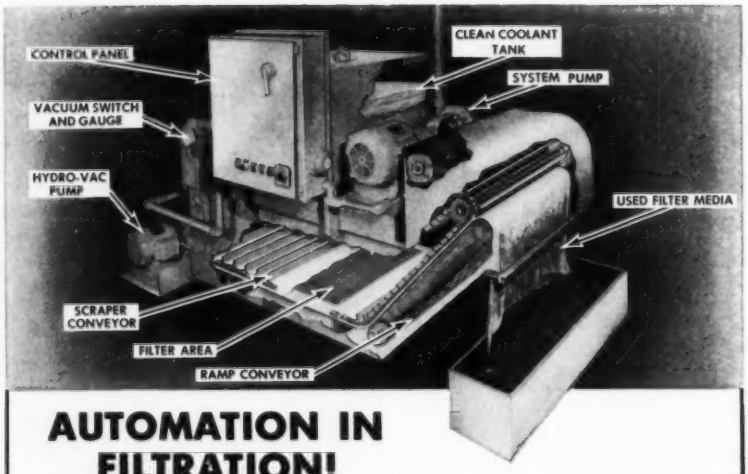
- Diameters from 5" to 9"
- Lengths up to 9"
- Thicknesses from 16 ga. to 1/8"
- Production 120 to 200 per hr depending on size.

AUTOMATION MACHINES & EQUIPMENT CO., INC.
3130 WEST MILL ROAD MILWAUKEE 9, WISCONSIN

Circle 731 on Page 19

springs. Models LFC-9 and LFC-10 are 2½ and 3-inch sizes which have a spring loaded piston which starts to open at the set pressure, and under greater pressure, opens completely to allow full-flow by-passing of excess oil. The spring tension can be adjusted to give varying operating pressures. **Fulflo Specialties Co. Inc.**, 430 Fancy St., Blanchester, Ohio.

Circle 460 on Page 19

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- Completely automatic operation
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- Fine degree of filtration
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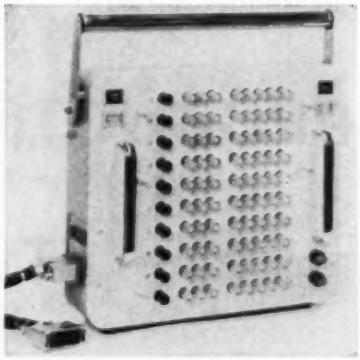
HYDROMATION FILTER CO.
19661 Schoolcraft Detroit 23, Michigan VErmont 8-0492

Circle 732 on Page 19



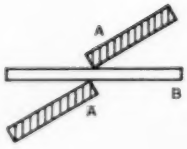
## Tape Simulator

Instrument has a capacity of 80 bits of information, with each bit entered by a pushbutton on the instrument's panel. The 80 buttons are arranged in 10 lines and 8 channels to coincide with the common 8-channel punched tape code. As each pushbutton is depressed it lights up to provide easy reading of the program that has been punched. Each of the ten lines can be reset by its own reset button, and the entire panel can be cleared for a new entry by a master clear switch.

When used with perforated tape systems, Model 0359 substitutes for the tape reader and can be used to

# new north multi-contact multi-purpose connectors

A prongs of fork contact
B flat pin contact



These new, compact and highly efficient plug and receptacle type connectors provide maximum connection concentration in a limited space. They are designed for electronic applications in cable-to-cable, cable-to-fixture, fixture-to-fixture, and are available in 40, 60, 80 and 100 pin sizes.

Firm contact is assured by the unique torsion pressure principle in which beveled end flat blade male connectors seat into flat, fork shaped female blades placed at an angle to the male plugs—assuring double contact, providing minimum contact resistance.

The new design of the mounting hardware features a handy locking bolt for securing the plug to the receptacle and a removable cover with captive screw for rapid wiring or inspection. The permanent cable clamp is adjustable to accommodate varied cable sizes. All connectors are available with either solder or taper tab terminals.

For full details, write

*ELECTRONETICS DIVISION*

***NORTH ELECTRIC COMPANY***

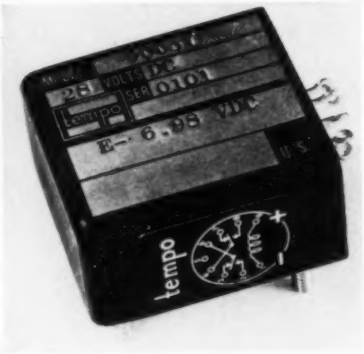
*625 S. MARKET ST.* *GALION, OHIO*

perform vital check-out and verification functions. In data logging and machine tool programming, or wherever punched tape systems are used, the simulator can act as a second signal source. In programming new tapes on a trial and error basis, the process of punching an entire tape to determine correct coding is eliminated. When a test point in a check-out system exceeds limits and verification is needed, the simulator can duplicate the tape without having to rerun or find the proper spot in the tape. It will also determine whether or not the limits coded on the tape are correct. **Hallamore Electronics Corp.**, 8352 Brookhurst, Anaheim, Calif.

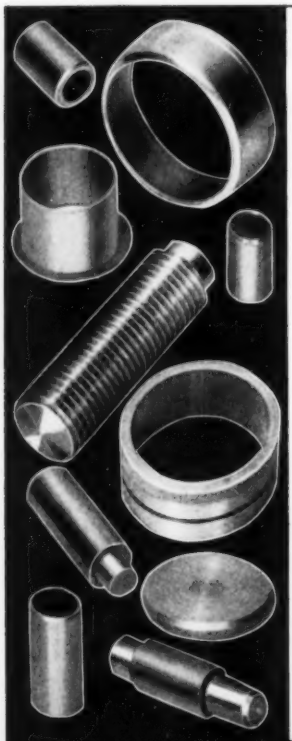
Circle 461 on Page 19

## Voltage Sensor

Silicon transistors are used in unit which senses dc voltages from 3 v dc and up. Accuracy is within ±5 per cent of the calibrated signal level. In operation, the unknown voltage being sensed is compared to an internally-generated reference voltage. When the voltage exceeds the reference by a few millivolts, the difference is amplified and transmitted to a trigger circuit. Upon receiving this voltage, the trigger circuit goes from the *Off* state to the *On* state, energizing the output device. Recommended temperature range is −55 to +125 C. Unit supply voltage can vary between 18 to 31 v dc. **Tempo Instrument Inc.**, P. O. Box 338, Hicksville, N. Y.




Circle 462 on Page 19

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There are models that handle tubing, pipe and bar stock from ⅛" diameter up to solid bar stock of 3" OD and tubing up to 8" OD.

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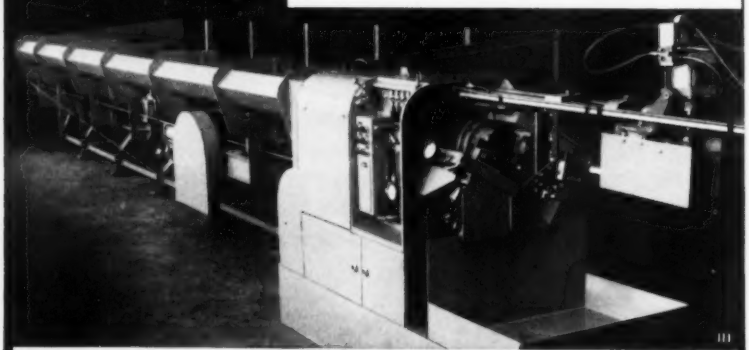
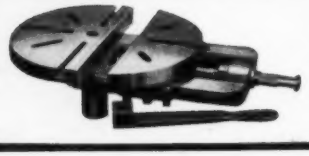
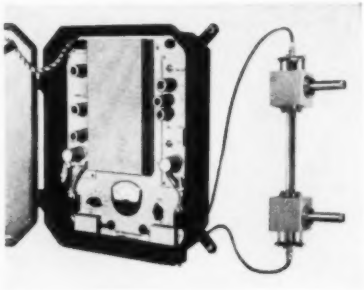




FREE TRIAL OFFER. Safe, positive, fast set-ups. The Modern Safety Drill Table handles odd, irregular shapes without V-blocks, clamps or parallels. Ideal for maintenance work. Guaranteed to save its cost in labor alone every 6 months. Sizes from 8" to 27½" dia. Try it at our expense. No obligation.

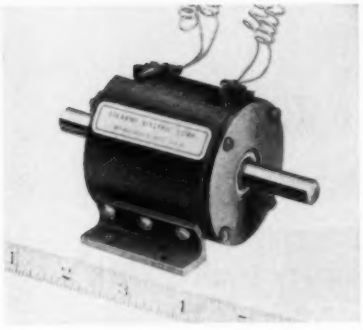



## Bubble Detector

Instrument can be used to detect undesirable or controlled bubbling in almost any liquid, in open or closed vessels, pipes or flumes. Detector is designed to be coupled with indicating, recording, or controlling instruments or with some type of alarm. Individual, as well as large quantities of bubbles can be detected; the strength of the output signal varies with both the size and number of bubbles. Minimum bubble size which can be detected is 0.001 inch diameter. In operation,

the sensing head assembly, located at the process, is cable connected in a continuous loop with the amplified unit, which can be remotely located. A pulsed ultrasonic signal passes through the liquid which is likewise flowing between the transmitter and receiver heads. The presence of bubbles weakens or interrupts the signal. The amplifier unit is comprised of four subassemblies: Transmitter, receiver, amplifier, power supply, and an operational analyzer. **Taylor Instrument Companies,** 95 Ames St., Rochester 1, N. Y.

*Circle 463 on Page 19*



## Clutch-Brake

In miniature combination unit, both the clutch and brake are magnetically set. Both the clutch and brake can be set independently by applying current to desired electromagnet. There is also a neutral position when current is turned off both magnets in the event free wheeling is required. The unit is available in any dc voltage up to and including 90 v dc, has a 1.55 current rating, with 8 lb-in. torque on both the clutch and brake side. It comes complete with bearing mounted drive and driven shafts. **Stearns Electric Corp.,** 120 N. Broadway, Milwaukee 2, Wis.

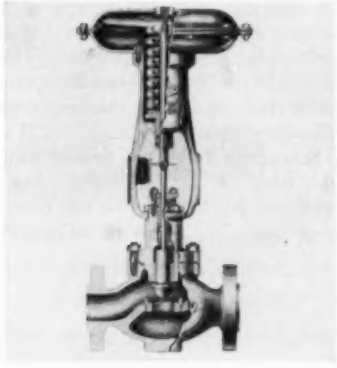
*Circle 464 on Page 19*

## Data Printer

Self-balancing potentiometer is used in conjunction with standard transducers such as strain gages, load cells, and thermocouples to provide a visual digital readout of

weight, pressure, position, voltage, current, temperature, and resistance measurements. Designated Digiprinter, the unit consists of a plug-in servo amplifier, power supply, servo motor, potentiometer, precision gear train, and a printing counter. It operates on 115 v ac, 60 cycle power. **Moran Instrument Corp.,** 170 E. Orange Grove Blvd., Pasadena, Calif.

*Circle 465 on Page 19*



## Control Valve

Single seated control valve is available in a range of sizes from ¾ to 10 inches for process and power plant applications. Features of the valve design include high capacity, ability to handle high pressures and pressure drops, and a wide selection of reduced capacity trim. Standard spring-diaphragm actuators are sized according to body rating. For applications beyond the scope of spring diaphragm actuation, springless diaphragm, cylinder, or electric drive actuators are available. **Mason-Neilan, Div., Worthington Corp.,** 63 Nahatan St., Norwood, Mass.

*Circle 466 on Page 19*


NEW
DYNAPAR
ZERO-SPEED
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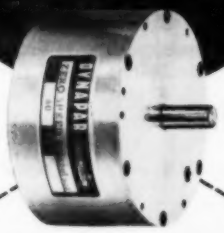
for precise industrial measurements and AUTOMATION control



• Rugged, heavy duty sensing units • Provide up to 2400 pulses per rotation • Extremely compact • Highly resistant to vibration • Wide temperature range • For continuous duty applications

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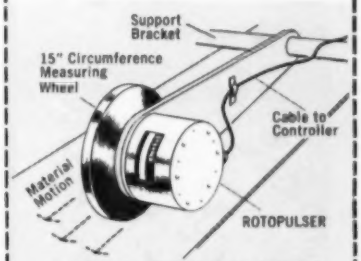


**AUTOMATIC CUTTING TO LENGTH**

ROTOPULSER connected to measuring wheel converts length into pulses. Remote controller counts pulses and actuates power shear when predetermined length is reached. Accuracy: to 5/1000th inch—at any speed!

Dynapar ROTOPULSERS are rotary sensing devices which convert all kinds of MOTION into shaft rotations, and then into digital voltage PULSES. These pulses are fed to remote digital readout or control devices for: *counting . . . numerical readout . . .* and *actuation of automatic control functions* on industrial equipment at any preset count. SEND FOR NEW ROTOPULSER BULLETIN #14B.

**Send for Application Data Sheets* describing ROTOPULSERS in these and other industrial applications. Please give details about your measurement-control problem.

DYNAPAR corporation

TRANSISTORIZED PROCESS CONTROLLERS • DIGITAL AUTOMATION CONTROLS • TACHOMETERS

*Circle 735 on Page 19*

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Our competition has some funny ideas about cable conveyors. Compare these true facts:

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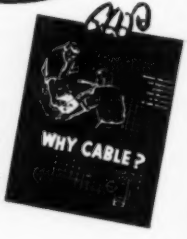
|---|---|
| **SPEED** | |
| Big problem | No problem |
| **WEIGHT** | |
| Whole problem | 1/6 of this problem |
| **LUBRICATION** | |
| Big problem | No problem |
| **WEAR** | |
| Big problem | No problem |
| **PAYLOAD** | |
| Less per HP | More per HP |

*Now, let us prove it!*

GO...

*... For the multiple Cable-Link benefits detailed in this free brochure. See your nearest Cable-Link distributor, or write the factory.*




Territories Available

A-C-L

Dearborn Cable-Link Conveyor

DEARBORN FABRICATING & ENGINEERING CO.
19440 GLENDALE • DETROIT 23, MICHIGAN

Circle 736 on Page 19

## Midget Air Cylinder

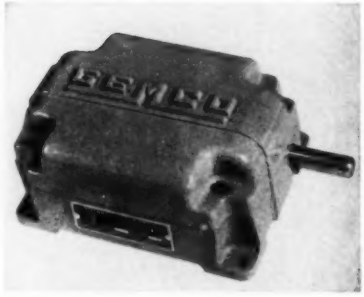
Double-acting unit has a one-inch bore, is suitable for air pressures up to 125 psig. It is capable of performing any push, pull, or reciprocating motion on parts of power presses, press brakes, clutches, and all types of doors, hatches, clamps, and material handling equipment. The unit can be neck, angle-leg, or clevis-bolt mounted. There are six models in the series in stroke sizes of 1, 2, 3, 6, 9, and 12 inches. Cylinder has a corrosion-resistant brass body and piston. The cartridge-type bronze bearings and piston rod seals can be replaced without dismantling the cylinder. **A. Schrader's Son, Div., Scovill Mfg. Co. Inc.**, 470 Vanderbilt Ave., Brooklyn, N. Y.

*Circle 467 on Page 19*

## Coding Device

Device can be fitted to any conveyor, carton sealer, packaging, or processing equipment. The coder is friction driven, will print or code the top, bottom, or sides of a variety of packages, and materials such as paper board, corrugated paper, wood crates, metal containers, metal, and cellophane. The coder consists of three rollers—a felt ink roller, a rubber transfer roller, and a type roller. There are two micrometer scale dials; One for adjusting the transfer roll to the type roll and the other to adjust the transfer roll to the ink roll. **Cozzone Marking Co. Inc.**, 18 Nuttman St., Newark 1, N. J.

*Circle 468 on Page 19*




## Rotary Limit Switch

Designed for heavy industrial usage, rotary limit switch has eight gear ratios ranging from 5:1 to 1750:1. Feature of the switch is the positive independent cam settings which allow adjustments of one cam without upsetting the position of the other. Unit is explosion-proof, has spdt contacts for reversibility of control circuits. It is rated at 125 v, 250 v, and 460 v, 15 amp ac; 125 v, ½ amp dc; 250 v, 14 amp dc. **Gemco Electric Co.**, 25685 W. Eight Mile, Detroit 40, Mich.

*Circle 469 on Page 19*

## Computer Tape

Reinforced, opaque computer tape is suitable for use in programming applications with photoelectric or mechanical readers. It has a dimensional stability which permits it to be run through readers thousands of times without breaks and without malfunction due to deformation or elongation of code signal holes or feed holes. Tape is available in two types. Model R-V-CT 52 is 0.0025-inch thick, is suitable for photoelectric reading. It comes in con-

STEAM

AIR

OIL

WATER

lever acting

direct acting

piloted piston

*if it flows...*

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Oil, gas, water, steam, corrosive fluids, refrigerants–makes no difference what you're handling... General Controls has a solenoid valve to do the job. The General Controls line is *complete*... pressure range from 0 to 3000 psi in normally open, normally closed, shut-off, 3-way and 4-way valves.

And this *single reliable source* can save you time and money... by delivering a quality product–backed by factory-trained field service representatives where and when you need them. Call on the man from General Controls for help in solving your automatic control problems.

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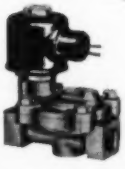

diaphragm

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Circle 737 on Page 19

tinuous lengths of 1800 ft, 1200 ft, 1000 ft, and 500 ft without splices. Model R-V-CP 23 is 0.0045-inch thick, is suitable for mechanical or photoelectric reading. It is furnished in over-all diameter rolls of 8, 6, and 4 inches. Both types are available in standard and special tape widths, with tolerances of ±0.003-inch, wound on either 2 or 3 inch ID cores. **Lamcote Div., Arvey Corp.**, 3500 N. Kimball Ave., Chicago 18, Ill.

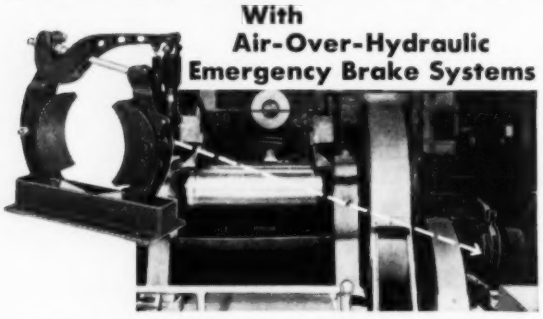
*Circle 470 on Page 19*

## Pressure Hose

Pressure hose is of synthetic construction, is suitable for hydraulic lines, hot paint lines, solvent lines, freon lines, fuel and oil lines, high pressure pneumatic service, high pressure $CO_2$, and oxygen lines. Minimum burst pressure is 9000 to 12,000 psi, depending on size. Temperature range is from −40 to 225 F. The hose consists of a seamless extruded inner tube of virgin polyamide material, a high tensile strength polyester reinforcement, and a cover of extruded polyamide formulation. A line of reusable couplings is provided for assembly of hose. Hose assemblies can also be furnished with factory crimped-on couplings. **Imperial Brass Mfg. Co.**, 6300 W. Howard St., Chicago 48, Ill.

*Circle 471 on Page 19*


**STOP "INRUNNING ROLLS" SAFELY**
**With**
**Air-Over-Hydraulic**
**Emergency Brake Systems**



Wagner A/H Emergency Brake Systems protect the operator (as required by safety codes) against the extreme hazards involved in operating machinery with inrunning rolls. An industrial-type brake is applied by an air-operated hydraulic power cluster to stop rolls quickly, smoothly, and with minimum strain on the drive. Systems incorporate safety devices to meet other emergencies, such as loss of air pressure or failure of power supply.

Brake assemblies are ruggedly constructed, are easy to install . . . require no special motor starters or control, no direct current. Maintenance is minimized . . . there is practically no lining wear, no heavy solenoid coils to burn out.

Apply these systems to your rubber or plastic mills, refiners, washers, crackers. Available with 6, 8, 10, 14, or 18 inch diameter brakes. Your nearby Wagner Sales Engineer has the complete story. Call him, soon.

W160-3

**Wagner Electric Corporation**
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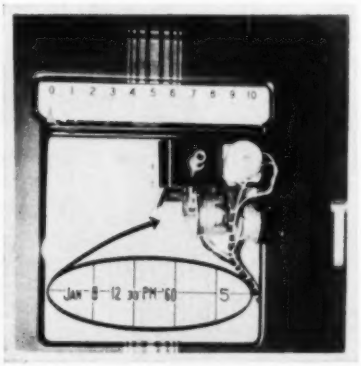
*Circle 738 on Page 19*


## Strip Chart Recorders

Instrument automatically prints date, time (to the nearest minute), and codes on strip chart recorders. The time clock operates continuously on a 60 cycle line, and the printing mechanism is provided for operation on any ac or dc voltage from 24-115 v. A single printing solenoid causes simultaneous printing of time and code. Up to 12 code numbers are available; they are selected by remote selector switch, stepping relay, or other combinations of contacts. Model RI-5, designated Identichart, is available for all makes of strip chart recorders. **Royson Engineering Co.**, Hatboro, Pa.

*Circle 472 on Page 19*


**ACRO WELDER MFG. CO.**
MILWAUKEE
WELDING ENGINEERS
MACHINERY BUILDERS
ESTABLISHED 1936

*Circle 739 on Page 19*


## Level Control

Transistorized level control is suitable for high and low level detection of liquids, granular solids, and liquid/liquid interfaces. Features of Model B-07 is the solid state circuit design which eliminates use of vacuum tubes. The explosion-proof unit is available for operation

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Circle 740 on Page 19



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A Model and Size for Your Every Requirement

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OUTSTANDING FEATURES

- All digits displayed on front viewing screen
- All digits uniform in size and intensity
- High-contrast viewing screen
- Digit style of your choice
- Colored digits of your choice
- Individual units may be group assembled for panel mounting

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1 9/16" wide
2 5/8" high
5 5/8" long
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Series 80000
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5 1/4" high
11 1/16" long
$33.00 each

Series 120000
1" wide
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3 3/8" long
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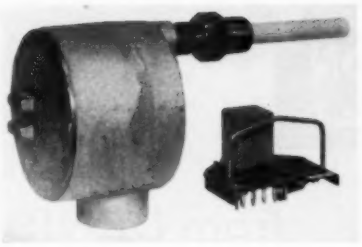
Quantity Prices On Request

INDUSTRIAL ELECTRONIC ENGINEERS, Inc.

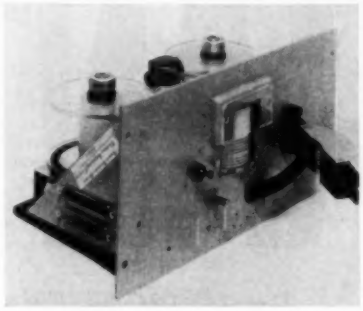
5528 Vineland Avenue, North Hollywood, Calif.

Circle 741 on Page 19

on 115 v, 60 cycles ac, or 12 or 24 v dc. It is furnished in either fail-safe or direct action. **Instruments Inc.**, P. O. Box 556, Tulsa, Okla.

Circle 473 on Page 19



## Tape Programmer

Bidirectional punched tape programmer is suitable for use in automatic test equipment and digital data processing systems. Model TP-201A uses 2-inch wide tape, with 1-inch for punched information and 1-inch for printed information to allow visual selection of any 1-inch frame within 250 feet of stored tape. The bidirectional electrical drive system uses positive detent action for positioning of the tape. Contacts are springloaded pins, gold-plated for low contact resistance. The self-contained storage reels can handle up to 250 feet of tape. Three other types of programmers are also available: Model TP-101 uses a 1-inch tape with no provision for printed information; Model TP-202 uses two separate 1-inch tapes synchronized for simultaneous reading of 160 bits of information; and Model TP-303 uses three separate 1-inch tapes for reading 240 bits of information simultaneously. **Electronic Engineering Co. of California**, 1601 E. Chestnut Ave., Santa Ana, Calif.

Circle 474 on Page 19

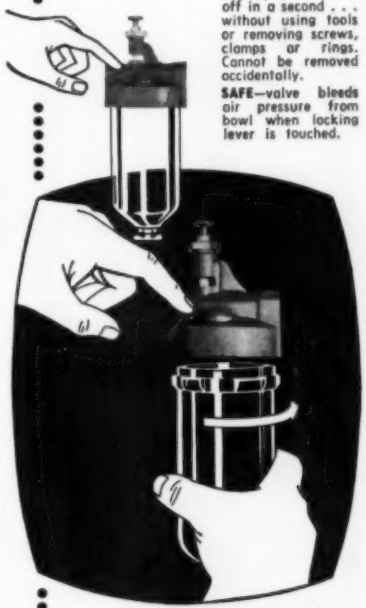

NOW AVAILABLE exclusively on the

WILKERSON #3014 LUBRICATOR

NEW KWIK-CHANGE BOWL

Simply touch the quick-release locking lever, turn bowl slightly and bowl is off in a second . . . without using tools or removing screws, clamps or rings. Cannot be removed accidentally.

**SAFE**—valve bleeds air pressure from bowl when locking lever is touched.



**Profit from these advantages of a Wilkerson 3014 Lubricator**

- 1 to 300 CFM
- Site-Flo gauge
- Two fill holes
- Fill while air pressure is on
- Bowl can be removed without turning off air

**PLUS**

The time-saving advantages of the Wilkerson

**KWIK-CHANGE BOWL**

**Note:** 3014 lubricator can be equipped with the Wilkerson auto-fill mechanism to maintain lubricant at safe level.

**Get complete information** on the versatility and cost-saving advantages of the new 3014 series.

Write for circular #1028.

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Circle 742 on Page 19

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# catalogs and literature

**Latest automation information. For copies use card on page 19.**

## Air Gages

*Sheffield Corp., Dayton, Ohio*—50 *page handbook*—Line of dimensional air gages is described in Catalog SPG-160. This includes Precisionaire column instruments, dial-type air gages, external grinding gages, and flatness gages. Sketches show the principles of gaging inside diameter, outside diameter, height, and width. Points discussed include how to select the right amplification for the gaging job, and when to use long-range air gages.

**Circle 475 on Page 19**

## Switch Control System

*Robotron Corp.*, 21300 *W. Eight Mile Rd., Detroit* 19, *Mich.*—4 *page pamphlet*—A proximity switch control system for automatic control of presses is the subject of Bulletin 27B26D-A. It describes how the control device serves as a built-in trouble-shooter to protect the user against scrap losses, downtime, die damage, and machine repair due to multiple heading. Illustrations show how the system works and how it automatically stops the press instantly in the event of malfunction, misfeed, or failure to eject.

**Circle 476 on Page 19**

## Plant Equipment

*Ingersoll-Rand Co.*, 11 *Broadway, New York* 4, *N. Y.*—8 *page bulletin*—Bulletin 223 entitled, "Products for the Plant" outlines reciprocating, axial-flow, and centrifugal air compressors; centrifugal pumps; steam condensers; steam-jet ejectors; vacuum pumps; air hoists; and air and electric tools. Size and capacity ranges of many units are given, as are recommended applications.

**Circle 477 on Page 19**

## Power Supplies

*Sorensen & Co., Richards Avenue, South Norwalk, Conn.*—32 *page catalog*—Data are given on more than 400 power supplies. This includes regulated dc supplies, frequency changers (variable frequency power sources), high-voltage power supplies (to 600 kilovolts), miniature transistorized power supplies, inverters and converters, and ac line-voltage regulators. A section on technical data discusses the selection and application of these products.

**Circle 478 on Page 19**

## Computer Control

*Scientific & Process Instruments Div., Beckman Instruments Inc.*, 2500 *Fullerton Rd., Fullerton, Calif.*—28 *page handbook*—Handbook S-4019 entitled, "A Return to Sanity in Computer Control," contains details on a step-by-step method for developing a highly reliable computer control system with a minimum capital commitment. The method takes the reader from the initial feasibility study stage, through the individually justified intermediate steps, to the completion of an automated control system composed of building block components. One section deals with questions and answers on computer control, while another gives the practical solution to computer control.

**Circle 479 on Page 19**

## Induction Heating Equipment

*Ajax Magnethermic Corp., P. O. Box* 839, 3990 *Simon Rd., Youngstown* 1, *Ohio*—8 *page bulletin*—Data are given on induction heating equipment for brazing, hardening, annealing, soldering, forging, and melting. Construction of the core-type melting furnace is explained. Charts list melting rates in pounds per hour.

**Circle 480 on Page 19**

## Data-Loggers

*Hanson-Gorrill-Brian Inc.*, 85 *Hazel St., Glen Cove, N. Y.*—12 *page booklet*—Equipment described can log a variety of data such as temperature, pressure, flow, and humidity, and automatically prepare a typewritten or punched tape record. It is also explained how memory units and alarm systems can be incorporated. Features of four different units are pointed out.

**Circle 481 on Page 19**

## Retainer Bearings

*Barden Corp.*, 200 *Park Ave., Danbury, Conn.*—4 *page pamphlet*—Retainer bearings described in Bulletin W-1 were developed to provide low-torque bearing reliability for gyros, synchros, small motors, potentiometers, and other applications requiring low-torque or extremely smooth operation. The stainless steel construction is explained. Notes are given on the company's engineering services.

**Circle 482 on Page 19**

## Telephone Type Relays

*Magnecraft Electric Co.*, 3354D *West Grand Ave., Chicago* 51, *Ill.*—24 *page catalog*—Data are contained in Catalog 160 on telephone type relays (medium size, small, miniature, and subminiature) with a range of contact combinations including bifurcated, heavy duty, and power contacts. Dimensional diagrams and photos cover plug-in relays; power, latch-in, snap action, and time delay relays; and relays for printed circuits.

**Circle 483 on Page 19**

## Pulse Transformers

*Technitrol Engineering Co.*, 1952 *E. Allegheny Ave., Philadelphia* 34, *Pa.*—4 *page pamphlet*—Data are listed in Bulletin PT-201 on line of miniature pulse transformers designed to meet Grade 5, Class R requirements of MIL-T-27A and MIL-T-21038. Circuits and design formulae for interstage coupling, vacuum tube blocking oscillator, and transistor blocking oscillator applications are shown. Values of transformer parameters are listed for primary inductance, leakage inductance, effective shunting capacitance, and turns ratios.

**Circle 484 on Page 19**

## Hydraulic Tracer Mill

*Famco Machine Co., 3100 Sheridan Rd., Kenosha, Wis.*—8 *page bulletin*—Hydraulic tracer mills in one, two, and three dimensional models are described in Bulletin HTMM 859. Preprogrammed automatic milling is explained, and the versatility of cutter movement is illustrated. Illustrations show the design features.

**Circle 485 on Page 19**

## 2-Way Valves

*Airmatic Valve Inc., 7313 Associate Ave., Cleveland 9, Ohio*—8 *page bulletin*—Data is contained in Bulletin 91022 on 2-way valves for air, oil, water, gas, or chemical use. The valves can be used for vacuums from 0 to 35 inches mercury, for pressures from 0 to 500 psi, and for pipe sizes from ¼ to 3 inches. Types of valves described include: Solenoid operated, manually operated, pilot operated, and time delay.

**Circle 486 on Page 19**

## Speed Reducers

*Dodge Mfg. Corp., Mishawaka, Ind.*—64 *page catalog*—Data are contained in Bulletin A692 on torque-arm, shaft-mounted speed reducers built for capacities up to 170 hp, with output speeds from 10 to 400 rpm, in single and double reduction series, with 5:1, 15:1, and 25:1 ratios. Descriptions are also given on reducers for flange mounting, vertical shafts, and right angle drives. One section covers screw conveyor drives which consist of conveyor trough ends.
These drives mount as a unit on screw reducer, packing gland, and drive shaft.

**Circle 487 on Page 19**

## Interlocking Flow Switch

*Automatic Controls Div., Hays Mfg. Co., 801 W. 12th St., Erie, Pa.*—8 *page bulletin*—Interlocking flow switch described in Bulletin 2600 provides protection and contributes to automatic operation for coolant supply systems, refrigeration equipment, supply line piping, and drench cooling. Flow capacity charts are given, and wiring diagrams show how the switch protects against insufficient flow and excessive flow.

**Circle 488 on Page 19**

## Special Machines

*Kahle Engineering Co., 3322 Hudson Ave., Union City, N. J.*—11 *data sheets*—Collection of data sheets contains information on eleven machines used for the miniaturization and glass encapsulation of diodes, condensers, resistors, and switches. Some of the equipment includes a final-seal machine for glass diodes; special purpose cat whisker welding machine; crystal mounting machine for diodes and transistors; glass-case cleaning machine for diodes; button stem machine for subminiature tubes; glass hole punching machine for sealed beam headlights; and a sealing-exhaust machine for radio receiving tubes.

**Circle 489 on Page 19**

## Microminiature Relays

*Filtors Inc., Port Washington, N. Y.*—24 *page catalog*—Line of sub and microminiature hermetically sealed relays is described in Catalog 4. Circuit diagrams are included, and sketches show mounting styles. A section discusses dry circuits; how to recognize them, and how to deal with them.

**Circle 490 on Page 19**

## Belt Conveyor Idler

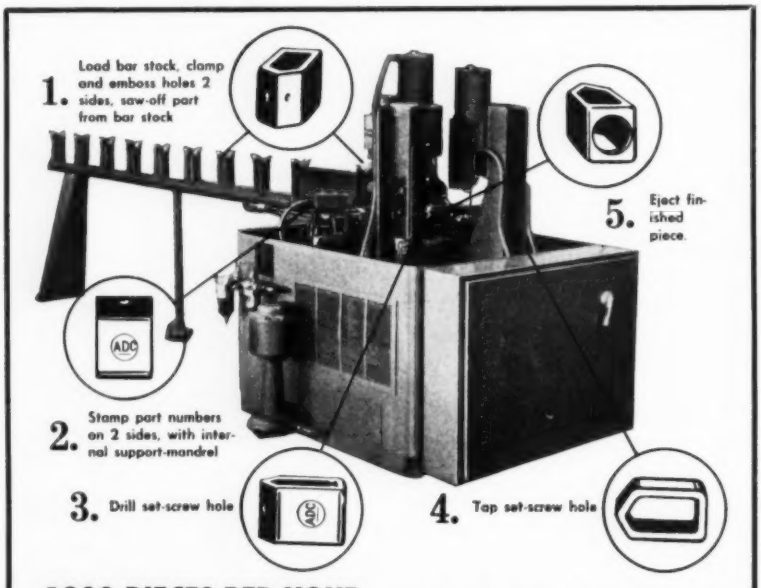
*Joy Mfg. Co., Henry W. Oliver Bldg., Pittsburgh 22, Pa.*—20 *page booklet*—Subject of Bulletin LD-111 is a belt conveyor idler designated Limberoller. The idler consists of a series of neoprene discs molded to a neoprene-covered, flexible steel wire cable suspended from two end-mounted bearings. Photos show construction features. Installation and application photos are also included.

**Circle 491 on Page 19**

## Transistorized Digital Computer

*Mechanical Div., General Mills Inc., 1620 Central Ave., Minneapolis 13, Minn.*—4 *page pamphlet*—Subject of pamphlet is Model 2003 transistorized digital computer. It can be used with external devices such as a typewriter, printer, tape reader, card punch, card reader, analog units, and control systems. Characteristics and specifications of the unit are noted.

**Circle 492 on Page 19**



1. Load bar stock, clamp and emboss holes 2 sides, saw-off part from bar stock
2. Stamp part numbers on 2 sides, with internal support-mandrel
3. Drill set-screw hole
4. Tap set-screw hole
5. Eject finished piece.
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**Circle 744 on Page 19**


## Hydraulic Presses

*Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus 16, Ohio*—24 *page catalog*—Catalog 120 covers ten sizes of multipresses in 1 to 75-ton capacities. Different control mechanisms explained include touch control, ram control, vibratory ram action control, and stroke limit controls. Data are also given on accessories such as benches, bolsters, index tables, and a foil feed marker. Illustrations show various case histories.

**Circle 493 on Page 19**

## Diaphragm Seals

*Brooks Rotameter Co., P. O. Box 432 Lansdale, Pa.*—20 *page booklet*—Diaphragm seals described in Bulletin 250 are designed for the protection of pressure instruments against corrosion and clogging, while they transmit pressure through an oil fill to the pressure device attached. Data listed for the different units include: Maximum working pressure, maximum working temperature, process connection, and gage connection. Sketches show layout dimensions.

**Circle 494 on Page 19**

## Actuators & Controllers

*Jordan Controls Inc., 3235 W. Hampton Ave., Milwaukee 9, Wis.*—16 *page booklet*—Details are given in Bulletin J-105 on remote, automatic, and punch card controls and actuators for positioning and

programming. Types of actuators described include rotary actuators which mount on shafts from ⅛ to 2 inches in diameter, linear actuators, and valve actuators. Schematic diagrams show typical applications of the tension and velocity control units.

**Circle 495 on Page 19**

## Material-Level Indicators

*Fuller Co., Catasauqua, Pa.*—8 *page bulletin*—Material-level indicators which automatically control the level of pulverized, fine, crushed, or granular material in bins or silos are the subject of Bulletin I-5-C. Details are given on two indicators; Model SG-4, a general purpose unit, and Model SG-4X, for hazardous dust conditions. The differences between the two models and their component parts are explained. Control switches and a safety pulse switch which indicates that the entire mechanism is in working order are also discussed, and a wiring diagram shows the operation of the switches.

**Circle 496 on Page 19**

## Heat Exchangers

*Carbone Corp., Boonton, N. J.*—20 *page booklet*—Data are contained in Bulletin PB-EM102-A on an impervious graphite heat exchanger designated Polybloc. A cutaway photo helps explain the principle of operation. Graphs list heat transfer coefficients and pressure drops. A chart lists the corrosion resistance of the heat exchanger.

**Circle 497 on Page 19**

## Shaft Position Encoder

*ASCOP Div., Electro-Mechanical Research Inc., P. O. Box 44, Princeton, N. J.*—12 *page booklet*—Booklet SPDE5M-030 entitled, "Shaft Position Digital Encoders With Magnetic Readout", contains data on 13-bit, 8-bit, and incremental encoders. Operating principle of a new type of magnetic readout is described, aided by illustrations. Also included are recommended simplified transistor circuitry for interrogation playback, detection, and amplification of the magnetic encoders.

**Circle 498 on Page 19**

## Transformers & Filter Reactors

*Chicago Standard Transformer Corp.*, 3501 *W. Addison St., Chicago* 18, *Ill.*—36 *page catalog*—Line of transformers and filter reactors described in Catalog CT9-59 includes hermetically sealed units such as bias, driver, filament, and 400 cycle transformers, and filter and 400 cycle reactors. Commercial grade transformers include input, isolation, miniature audio, modulation, output, and plate and filament transformers. Types of reactors include: Filter, modulation, and 400 cycle.

**Circle 499 on Page 19**

## Gear Motors & Reducers

*Sterling Electric Motors Inc.*, 5401 *Telegraph Rd., Los Angeles* 22, *Calif.*—8 *page bulletin*—Slo-speed gear motors and Slo-speed separate motor reducers are described in Bulletin 198. A cutaway photo shows the design features; other photos show the basic unit with the numerous modifications available. Sketches show the many mounting positions in which these units can be used.

**Circle 500 on Page 19**

## Conversion Factors

*Automatic Electric, Northlake, Ill.*—21 *page booklet*—Conversion factors compiled in Bulletin 1956 are those most frequently used in converting the fundamental electrical and magnetic units. Other factors given are conversion units for: Area, angles, angular acceleration, angular velocity, flow of water, force, heat and energy, length, linear acceleration, power, pressure, temperature, and weight.

**Circle 501 on Page 19**

## Tableting Equipment

*Arthur Colton Co.*, 3400 *E. Lafayette, Detroit* 7, *Mich.*—8 *page bulletin*—Bulletin AC-61 gives a pictorial review of machines for tableting pharmaceuticals, chemical catalysts, food products, paints, electronic discs, ferrite cores, powdered metal parts, and plastics. Other equipment covered includes: Drying ovens, coating stands, mixers, granulators, tablet dusters, hard capsule banders and fillers, tablet counters, and power triturate machines.

**Circle 502 on Page 19**

## Control Valves

*Ralph N. Brodie Co., San Leandro, Calif.*—8 *page bulletin*—Data are contained in Bulletin 668A on control valves in sizes from 2 to 12 inches, having a maximum working temperature of 150F at 400 and 600 psi. Construction and operation are explained, and color coded flow diagrams are given. Schematic drawings show typical installations.

**Circle 503 on Page 19**

## Pneumatically-Actuated Valves

*Conoflow Corp.*, 2100 *Arch St., Philadelphia* 3, *Pa.*—8 *page bulletin*—Line of pneumatically actuated valves in sizes from ½-inch through 6 inches is described in Bulletin HB-7. The close-coupled valve actuators described include: Springless diaphragm, cylinder, and spring and diaphragm types for either on-off or throttling control applications. One section gives details on valve sizing and flow coefficients to help in the selection of the proper valve.

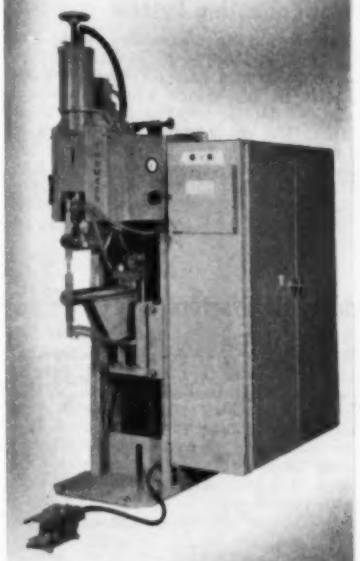
**Circle 504 on Page 19**

## Synchros

*Avionic Div., John Oster Mfg. Co.*, 1 *Main St., Racine, Wis.*—16 *page booklet*—Catalog 4000 contains data on line of size 8, 10, 11, and 15 synchros. Physical, electrical, and mechanical characteristics are listed, and dimensional drawings and circuit diagrams are given. Also included are definitions of synchro parameters.

**Circle 505 on Page 19**


The finest RESISTANCE Welders — competitively priced!



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**Circle 745 on Page 19**

## Thermocouple Assemblies

*Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Avenues, Philadelphia 44, Pa.*—40 *page catalog*—Thermocouple assemblies described in Catalog G100-1 include general purpose straight assemblies; angle assemblies; high-speed, small OD assemblies; and spring-loaded, high-speed assemblies. Special use assemblies are listed for high-pressure, high velocity steam; for injection molding; for sulphuric acid pickling tank; for the metals industry; and for the glass industry. Selection information given includes thermocouple calibration, wire size, and element length.

**Circle 506 on Page 19**

## Data Collecting System

*Friden Inc., San Leandro, Calif.*—18 *page booklet*—Subject of Bulletin SP-8665 is Collectadata, a data collecting unit applicable to any system where fast channeling of data to a central location is essential. The equipment which consists of a transmitter (using either edge or tab cards) and a receiver is described, and details are given on the various applications. System diagrams are also included.

**Circle 507 on Page 19**

## Magnetic Starters

*Clark Controller Co.*, 1146 *E. 152nd St., Cleveland 10, Ohio*—8 *page bulletin*—AC magnetic starters in sizes from 0 through 4 are described in Bulletin PL 12-8-160. The arc quenching principle which provides greater contact life under heavy current loads and severe arcing conditions is explained and diagrammed. Also included is a pictorial review of the installation procedure.

**Circle 508 on Page 19**

## Production Equipment

*Barnes Drill Co.*, 836 *Chestnut St., Rockford, Ill.*—8 *page bulletin*—Equipment outlined in Bulletin GC-60 includes transfer machines, production units, programming machines, standard drills, coolant cleaning machines, and hydraulic honing machines. Applications and parts are listed, as are machine capacities.

**Circle 509 on Page 19**

## Transducer

*Electric Regulator Corp., Pearl St., Norwalk, Conn.*—4 *page pamphlet*—Feature of Bulletin 5.501 is a series of step-by-step drawings which show how the transducer can change 1/10-inch of mechanical motion into stepless control of up to a quarter-kilowatt of power. A specification sheet included with the pamphlet contains a 3-step procedure used in selecting a transducer for a specific application.

**Circle 510 on Page 19**

## Flash-Butt Welders

*Taylor-Winfield Corp., Warren, Ohio*—16 *page booklet*—Resistance flash-butt welding processes outlined in Bulletin 7-913 are applicable on automotive parts, window frames, and small electronic components such as germanium diodes. Photos show types of clamping, flash, and upset mechanisms.

**Circle 511 on Page 19**

## Belt Conveyor Idlers

*Hewitt-Robins Inc., 666 Glenbrook Rd., Stamford, Conn.*—48 *page catalog*—Belt conveyor idlers described in Bulletin 171 can be used in all types of service—troughing, impact, troughing trainer, transition, deep trough, return, flat belt, impact feeder, return trainer, feeding and picking, live shaft flat belt impact, wire rope, and rubber spiral idlers. Data are given on 134 styles of idlers. Details of construction are noted, and a comparison of 10 competitive designs is listed.

**Circle 512 on Page 19**

## Stepping & Selective Relays

*G. H. Leland Inc., 123 Webster St., Dayton, Ohio*—6 *page pamphlet*—Hermetically-sealed stepping and selector switches designed to protect against moisture, dust, and fungus are described in Bulletin D-1059. This includes physical, performance, and environmental data. Photographs and line drawings are given of models ranging from a 2-pole, 2-position stepper weighing less than 12 oz to a 34-pole, 2-throw unit that weighs 2 lb, 4 oz.

**Circle 513 on Page 19**

## Data Input-Output Machine

*Industrial Products Div., Royal McBee Corp., 740 N. Main St., West Hartford 17, Conn.*—4 *page pamphlet*—Bulletin IP-01 describes machine designated Codewriter which provides the machine coupling to data processing and data handling systems. Data are given on three basic models: The input Codewriter, the output Codewriter, and the input-output Codewriter. A schematic diagram shows an application of the input-output Codewriter in a process control computer system.

**Circle 514 on Page 19**

## Precision Comparator

*Optimized Devices Inc., 864 Franklin Ave., Thornwood, N. Y.*—14 *page booklet*—Subject of handbook is a precision comparator which performs the function of comparing a variable dc voltage to one or more reference voltages and determining if the test parameter is above or below the reference, or within regions established by a number of references. Numerous working circuits show how to use the device in a variety of measurement problems.

**Circle 515 on Page 19**

## Dehydration Units

*J. F. Pritchard & Co., 4625 Roanoke Parkway, Kansas City 12, Mo.*—4 *page pamphlet*—Packaged dehydration units described in Bulletin 160-1 reduce the moisture content of gases or liquids to very low levels and eliminate formation of free water or ice. They are applicable on air operated instruments and controls, air operated tools, carbon dioxide gas production, and bottled gases. There is a selection chart for dryers and oil absorbers. A performance chart shows water content of air at various pressures and saturation temperatures.

**Circle 516 on Page 19**

## Air Conditioning/Drying Systems

*Surface Combustion Div., Midland-Ross Corp., 2375 Dorr St., Toledo 1, Ohio*—16 *page booklet*—The air conditioning and drying systems described in Bulletin K-160 can be used to stop condensation; speed drying and other processing operations; obtain sub-freezing dewpoint; and make air sterile to hospital standards. Humidity conditioner consists of two special coils located on separate pumps with a single common pumping unit. A schematic drawing shows the operation. Details are also given on prefabricated standard test rooms which are designed to produce almost any temperature, humidity, and bacteria controlled conditions desired for product testing.

**Circle 517 on Page 19**

## Differential Pressure Transmitter

*Fischer & Porter Co., 475 Jacksonville Rd., Warminster, Pa.*—6 *page pamphlet*—Subject of Bulletin 91-251 is a differential pressure transmitter. The effects of flow pulsations on differential pressure measurement are discussed, and a cutaway photo helps explain how adjustable internal damping is achieved with a needle valve. Numerous graphs show output signals at various valve openings.

**Circle 518 on Page 19**

## Drill Press Feeds

*Beckett-Harcum Co. Inc., 985 W. Locust St., Wilmington, Ohio*—8 *page bulletin*—Air and hydraulic powered drill press feeds and air powered tapping-drilling machines are described in Catalog F-60. Types of press feeds include standard duty, heavy duty, and gear head air powered feeds, either mechanically or electrically controlled; and a hydraulic powered drill press feed for automating larger and heavier types of drilling machines. The drilling and tapping machines include floor and multiple unit table combinations of machines for drilling only, or for performing both drilling and tapping.

**Circle 519 on Page 19**

## Control Instruments

*American Measurement & Control Inc., 240 Calvary St., Waltham 54, Mass.*—*collection of data sheets*—Components and instruments for servosystems are described in data sheets. This includes torque motors for continuous operation up to 700F, servo valves, flow transducers, precision current bridge, servo amplifiers, and phase control units. Charts list performance characteristics, and sketches show outline dimensions.

**Circle 520 on Page 19**

## Electric Transmission Systems

*Instrument Div., International Register Co., 2620 W. Washington Blvd., Chicago 12, Ill.—4 page pamphlet*—Electric transmission systems for remote pressure reading and maximum or minimum signals at one or more locations are described in Bulletin NR-10. Data are given on both transmitters and receivers which can be used in chemical or petrochemical plants, power plants, oil refining, and food processing. A cross-indexed table lists case, Bourdon tube, and socket materials. Mounting instructions are also included.

**Circle 521 on Page 19**

## Data Collector

*Control Data Corp., 501 Park Ave., Minneapolis 15, Minn.—8 page bulletin*—Subject of bulletin is Model 180 data collector which provides on-the-spot information for production scheduling, machine loading, schedule and incentive payroll planning, and cost and inventory control. Features of the unit are pointed out and specifications listed.

**Circle 522 on Page 19**

## Insert Valves

*Humphrey Products Div., General Gas Light Co., Kalamazoo, Mich.—4 page pamplet*—The cartridge type valves described in Bulletin 400 are put inside the cylinder or manifold, or inside a control handle, making the valves an integral part of the pneumatic or hydraulic unit. Data are given on ⅛ and ¼ inch valves. Outline drawings of the units are also included.

**Circle 523 on Page 19**

## Conveyor Control Systems

*Maico Electronics Inc., 21 North Third St., Minneapolis 1, Minn.—4 page pamphlet*—Conveyor control systems outlined in Bulletin 1193 are for horizontal or vertical material handling or combinations of both. Diagrams show typical systems in a factory and warehouse. Suggestions are given on how to determine the number of modular components required for a system.

**Circle 524 on Page 19**

## V-Belts

*Boston Woven Hose & Rubber Co., Div., American Biltrite Rubber Co. Inc., Box 1071, Boston 3, Mass.—64 page catalog*—Numerous selection tables are given in Bulletin 2011-R200 on line of industrial V-belts, with instructions included on how to use the tables. Sketches show the five cross sections available and reasons for the different sizes of belts are given. Non-standard drive instructions are also included, along with formulas for calculating belt length.

**Circle 525 on Page 19**

## Soaking Pit Control Systems

*Controls Div., Hagan Chemicals & Controls Inc., Hagan Center, Pittsburgh 30, Pa.—12 page booklet*—Various components and phases of soaking pit control systems are described in Bulletin MSA-177. Four types of control systems with varying requirements are covered in details, with emphasis on centralized soaking pit control by means of solid-state magnetic components. The transition from hydraulic to pneumatic to electronic controls is outlined, and a summary is given on the research work done in this area.

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## Rotary Components

*G. H. Leland Inc., 123 Webster St., Dayton, Ohio—8 page bulletin*—Bulletin A-1259 contains data on rotary solenoids, selectors, and Syncramental stepping motors. Physical and performance characteristics are listed, and notes are given on how to select the proper unit for an application. Also included are circuit diagrams and line sketches showing mounting styles.

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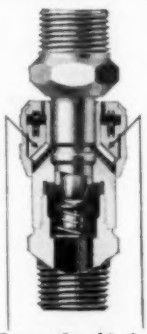
## Control Instruments

*Eldorado Electronics, 2821 Tenth St., Berkeley 10, Calif.—8 page bulletin*—Instruments for nuclear research and process control are described in Bulletin D-100. This includes current integrators, linear amplifiers, pulse height analyzers, and decimal scalers. The various units are illustrated, and specifications and features are noted.

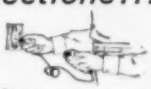
**Circle 528 on Page 19**

*Wherever you have fluid line connections...*



Tamper-Proof Socket Head — with leak-proof, minimum wear, locking device.

—AS EASY AS PLUGGING IN YOUR ELECTRIC SHAVER



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**Circle 746 on Page 19**

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If your operation involves the manufacture or processing of parts in volume quantities, it will pay you to investigate the cost saving advantages of Feedmatic automated equipment. *Send us your problem today!*

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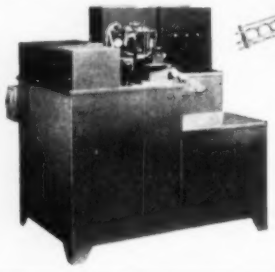
Automatic Gaging Machine measures and sorts parts. Adjustable stops, anvils and gage heads to facilitate change over to different size parts. Tolerance of electrical gages adjustable from .0005 to .020.



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Circle 747 on Page 19

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AUTOMATION abstracts

## EDP IN DISTRIBUTION

By J. P. SHUCHTER
Director—Market Research
Federal Pacific Electric Co.
Newark, N. J.

IN Newark, N. J., Federal Pacific Electric Company operates a complex of modern plants producing specialized electrical equipment for construction and industry. From its assembly lines pours an assortment of packaged products for the distribution and control of electric power—circuit breakers, load centers, switches, motor controls, instruments—more than 2000 catalog items, ranging in price from one to several hundreds of dollars.

From Newark, forty million pounds of freight, packaged in our distinctive yellow and red cartons, enter our national distribution system in a year. The bulk moves first to a strategically placed group of seventeen warehouses. These provide a local pool of stock for a thousand authorized distributors who in turn service many thousands of electrical and building contractors, and industrial and utility accounts.

Federal Pacific is a growth company. Forty million pounds of freight per year is seven times the volume of a decade ago. As is well known, the growth process inevitably creates backward areas in corporate development. In the case of our company, particular attention has gone into product design, manufacturing, and selling. The distribution process itself—unglamorous and heavy with detail—took a back seat.

Finally, the sheer weight of the distribution system forced us to turn real attention to it. We installed a small-scale computer which features a gigantic memory and quick access to an extensive file of data. Our studies showed beyond question that the machine had the capacity and know-how to handle our supply system.

Nonetheless, for the past six months we have been "spinning our wheels." Our first efforts proved disappointing. The system now is being re-built on a more substantial basis, and this time we think we have hit the right combination. In this case history study, with its frank exposition of what happened, I hope you will find lessons applicable to your own business.

When we determined that the time was right for a computer and a fully controlled warehouse inventory system, backed up by appropriate production schedules, this was the picture: 1. Our total inventory was unbalanced in vital respects. 2. The dollar value of our inventory was excessive by industry standards. 3. There were numerous instances of poorly placed inventories. 4. The company was operating a vast distribution network on a scale that demanded improved controls.

To finance each million dollars of inventory costs us some $50,000 annually, to pick a rough figure. To pay for itself a system must fit into that framework. Since this is approximately the plus-cost of a small-scale computer, we set as our first objective the reduction of inventories by $1 million. The plus features we expected to get in terms of increased sales, better space utilization and efficient administration are extra benefits. And of course we visualized an inventory reduction bigger than this first million.

### Don't Rush In

We can't say we weren't warned. The first advice we received from the computer industry five years ago was: Don't rush in! Bring in specialists; set up a committee; assign an executive to concentrate on the problems and applications for one or two years. Soak up know-how; then go in with your applications.

We followed an expedient version of this approach. We obtained a procedures man and a specialist well in advance. Some of us dutifully attended briefing courses, but when it came to the installation date—we remained inadequate to the task. Willy-nilly we joined the two out of three outfits whose first applications have had to be described as false starts. In the process, as I now see it, we made the following errors:

1. *The pedestal error.* This marvelous equipment is set up on a pedestal and expected to perform magical maneuvers far above the common range of past company experience.

2. *The "leave-it-to-experts" error.* The terms and potentials of the equipment are so far outside past management experience that the working out of problems is left to the experts. Usually these experts have limited ranges and solve problems expediently rather than in depth.

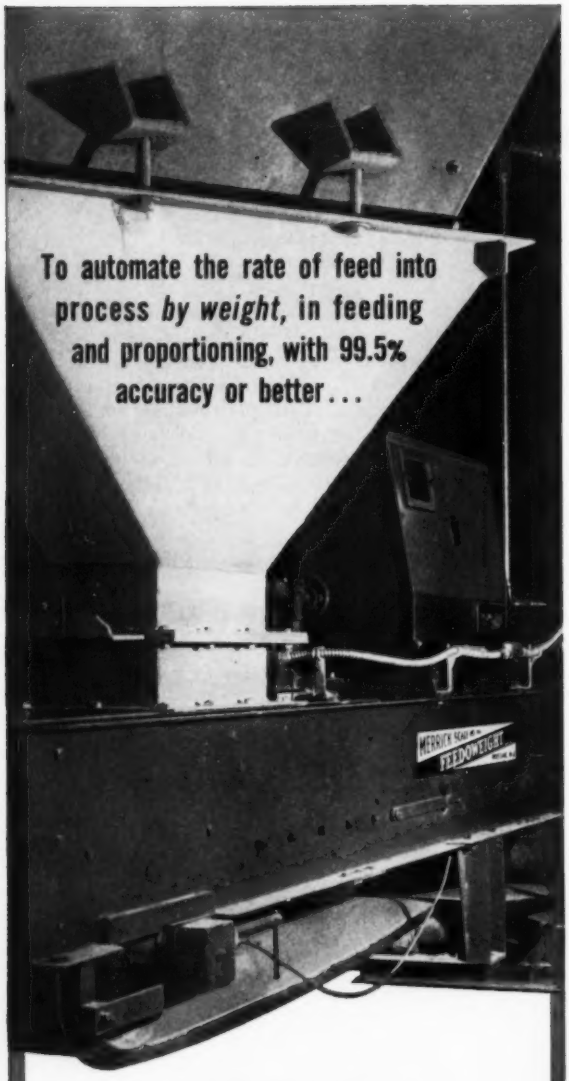
3. *The remote control error.* In the press of other duties, executive administration of the system deteriorates into passing on procedures rather than shirt-sleeve participation.

In short, the know-how of a going organization from executive to clerical levels is somehow ignored and rendered ineffectual while the abracadabra of the computer jargon grows with a life of its own.

The results in the case of Federal Pacific were: 1. The procedures established were much too elaborate, much too sophisticated, for the stage of development of the company's distribution system. 2. The voluminous reports were fraught with error and inadequate for action. 3. The installation failed to enlist the co-operation and support of the people who had to work with it.

### Corrective Steps

We were faced with a stern alternative. Make it work or toss it out! These are the steps we have taken

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to date:

1. *Tightening internal paperwork.* The computer demands near-perfection in its input. We learned that clerical processing makes thousands of unnoticed and trivial corrections, interpretations, and adjustments—something like the tiny corrections you make while driving—which the computer can only partially duplicate. The paperwork must be organized and shaped for machine use.

In our case this has meant an upgrading of personnel at the source of records, as well as improved formal methods.

2. *Knee-deep administration.* Responsibility has been firmly assigned to a corporate officer. Not only must he make the process work, but must involve all administrative personnel whose task involves use of the results. There are no more onlookers.

3. *Simplified methods.* The initial formulation we threw into the computer was of the womb-to-tomb variety. Every step was organized into a beautiful model. The machine internally calculated a minimum-maximum level for each product, the relationship of field stock levels to central warehouse levels was cleverly spelled out, and the production orders were created with ingenious attention to the needs of our farflung distribution system.

Unfortunately, we planned to install this formula not by leaping successive hurdles over a period of years, but in one gigantic pole vault. We found this would not work. We needed an evolutionary, organizationally-directed approach rather than the *deus ex machina* devices which soar with the wings of imagination, but fall to the ground in the trial spin.

We have therefore reverted to methods which duplicate clerical methods commonly used. Some later day, when stock rotation approaches efficiency, we will introduce more sophisticated concepts for machine handling.

4. *Human intervention.* One of the problems of mechanical methods is that raw material for human judgment moves out of sight—into holes in punched cards or magnetic charges on spinning discs. The machine renders a series of judgments, as instructed, and man, at the end, is confronted with a wide array of end results. Somewhere in the process the conditions for evaluating the results have gotten lost.

In initial stages, human intervention must be frequent. The machine process must include significant read-outs of background factors. In short, at this stage, the machine is developing—with more speed and accuracy—into a reasonable facsimile of a crew of efficient clerks.

5. *Evaluation and planning.* We are focusing a continuous spotlight on the method itself. Further uses of the equipment will have the widest and deepest scrutiny so that the first naive errors in application are not compounded. False starts are extremely expensive in equipment and manpower—not to mention morale.

Without question, the system is starting to roll, and we are well on the way toward balancing out our stocks; the new gears are starting to mesh. We believe the marriage of a computer to reality will be happy and fruitful.

In pulling in our horns, and backing off from a highly imaginative to a more practical approach to the distribution problem, Federal Pacific is facing the realities of the moment. But there is a higher reality which is also within our field of vision. Beyond the prosaic use of the computer as a substitute for a dozen clerks, there is a potential for lines of development far beyond the capabilities of a clerical staff. The use of electronic data processing equipment as a mere substitute for a dozen pencils is as unschooled in its way as the attempt to turn it into a master-mind overnight. My point is not that perspective should be eliminated,


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but that it should be programmed.

It is wholly possible that our abandoned program may now become precisely our program for 1963. We may take advantage of the machine's voracious appetite for facts to introduce indices of market conditions or seasonal factors as a thermostat for inventory levels; we may take advantage of the capacious memory system to store rates of sales at levels we never found expedient in clerical activity; we may use the machine's capacity for integrating a vast assortment of factors to shape a unique forecasting method. We may gear the system to the size of economical production runs and economic shipping weights and freight time. As we achieve some or all of these goals, we close in on our objective picture of perfection.

Beyond these concepts lies yet another fertile field of exploration. When we have solved and automated our warehouse supply problems, what of the step beyond? Distributor stocks are nothing but miniature warehouses. If we can control our own warehouse inventories with economy and precision, what of the next step, introducing similar controls on distributor inventories? The computer could, under this concept, constantly evaluate the distributor's stock in terms of his sales rates, market and seasonal factors and, when necessary, speed a shipment to the distributor's shelves.

*From a paper entitled "E.D.P. and Distribution," presented at the Conference on Distribution Management of the American Management Association, New York, October,* 1959.

## STRAIN GAGE USE

By LEON J. WEYMOUTH
Manager, Strain Gage Applications
Electronics & Instrumentation Div.
Baldwin-Lima-Hamilton Corp.
Waltham, Mass.

BONDED FILAMENT strain gages have been used to translate mechanical phenomena into electrical signals providing accuracies in the measurement of load, pressure, torque, acceleration, and dimensional changes never before achieved by other methods. These highly versatile tools are available in literally hundreds of sizes, shapes, and descriptions and have been adopted for use under practically every adverse environmental condition imaginable. However, the data and accurate interpretation of results obtained with strain gages depend upon an accurate knowledge of expected environmental conditions, selection of the proper gage type, associated accessories, and the planning and conduct of their use.

The major limiting environmental variable affecting strain gage performance is temperature. In the measurement of static strain, where electrical stability is required, other environmental variables such as moisture, corrosive fluids, hydrostatic pressure, oxidizing atmospheres, radiation, etc., limit the accuracy of strain gage results unless the effects can be measured and compensated for, minimized, or eliminated.

In considering temperature effects on strain gage performance, a natural division into somewhat restricted ranges of temperature is created by the limitations

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Automatic simultaneous winding of 2 to 5 group concentric coils . . .
*LOWEST MACHINE INVESTMENT PER UNIT PRODUCED.
• Winding speed at 325 RPM
• Preparation time: 4-pole, ¼ minute; 2-pole, ⅝ minute.
• One operator can readily tend two or more machines.
• Automatic cutting and anchoring of leads.
• Winds greater range of stator lengths.
* Production example: 4-pole stator with 3-group concentric coil per pole at 125 turns per coil produces 88 stators per hour; 2-pole with 5-group concentric coil per pole at 159 turns produces 58 stators per hour.

of the gage materials and accessories. These broad and slightly overlapping ranges are: −400 to +75 F, 50 to 500F, 500 to 1200F.

### Strain Sensing Alloys

All of the common strain sensing alloys undergo some degree of metallurgical change at elevated temperatures which alters the temperature coefficient of resistance and/or resistivity. This results in nonrepeatable "apparent strain" versus temperature characteristics or zero drift with time at constant temperature. There is a fairly repeatable deterioration of gage factor (strain sensitivity) with increasing temperature which appears to be independent of other metallurgical or electrical changes.

Some copper-nickel alloys have a fairly uniform gage factor over a limited operating temperature range. The temperature coefficient of resistance and resistivity is permanently altered between 450 and 600F; and the temperature coefficient, while repeatable, becomes highly negative below 50F. A safe operating range for these alloys without carefully controlled compensation for drift and temperature response is 50 to 500F.

Chrome-nickel alloys which also include small percentage additions of iron, aluminum, or cobalt are commonly used in the high temperature range and display a nonuniform gage factor with increasing temperature. A strain sensitivity reduction of 10 per cent between room temperature and 1000 F is common. Changes in resistivity observed as zero drift with time at temperature vary somewhat with these alloys. The amount of drift that can be tolerated for any particular set of conditions will dictate the selection of alloy, but the range is limited to 700 to 800F for zero stability within 50 to 60 microinches per inch per hour, regardless of choice.

Platinum and platinum alloyed with materials such as iridium, tungsten, rhodium, etc., enjoy very high gage factors (2 and 3 times other alloys mentioned), but the strain sensitivity decrease with temperature can be as great as 50 per cent for a 300 to 400F temperature rise. Zero stability of pure platinum is excellent at high temperatures but the alloys display varying degrees of drift as low as 600F. Platinum and its alloys cannot be considered satisfactory high temperature static strain sensing alloys and must be used with caution even for dynamic measurements.

### Carrier Materials And Cements

The over-all performance characteristics of the strain gage, regardless of the strain sensing material used, is dependent upon the ability of the gage carrier materials and bonding cements to faithfully transmit the surface strains to the sensing element. The two components are generally of similar materials or have similar characteristics, although it is possible, for example, to match an elevated temperature gage carrier with a room temperature adhesive in order to achieve the improvement in long-term stability offered by the

Ses-Matic AIR FEED
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STEEL, ALUMINUM, PLASTIC, LEATHER, ETC.
Model AFR-1818 shown with Pull-Thru Stock Leveller attached.
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specific carrier.

Paper type gages and nitrocellulose cements are in general limited to normal ambient temperature usage although they have been successfully tested at approximately −320F on aluminum and at temperatures up to 180F depending upon the grid configuration and construction.

Bakelite (phenolic and cellulose fiber matrix) type gages bonded with a filled Bakelite cement are generally limited to 350F operation. When improved phenolics are combined with a glass fiber matrix and the gage is bonded with a high temperature filled epoxy adhesive, the temperature range can be extended to 450 or 500F. This combination has been proved equally successful in the low temperature range down to −320F. Ceramic cements have been used successfully for particular low temperature applications.

Unfilled epoxy carriers and room-temperature-curing epoxy cements are limited to 150F operation because of reduced shear strength of the unfilled resin. There appears to be no advantage in using high temperature filled epoxy adhesive with the unfilled epoxy adhesive carrier. The epoxy gage type has not been thoroughly evaluated below −100F.

### Lead Wires

It is possible to alter the true strain gage characteristics by poor selection of lead wire and insulation materials which are actually part of the strain gage resistance within the conventional bridge circuit. When a symmetrical three wire system is employed and uniform temperature exists at and along the active and compensating gage leads, then temperature compensation is achieved. These carefully controlled conditions for the gages or lead wire seldom exist, and the effects on the combined strain sensitivity, temperature sensitivity, and stability may become significant. For this reason it is advisable to select a lead material with low, stable resistivity and a minimum temperature coefficient. Nickel clad copper, stainless steel clad copper, and nickel clad silver wire are generally serviceable in the respective temperature ranges of 700 to 1000F, 800 to 1300F, and 1000 to 1500F depending upon the length of test and the stability requirements. Nichrome wire or ribbon material has a more desirable temperature coefficient of resistance than clad copper materials but forty times the resistivity and is generally utilized as an intermediate lead connection for the range from 700 to 1000F.

The lead wire insulation should be equivalent to the electrical insulating quality of the bonding cement employed. There are many varieties of plastic, glass, and flexible ceramic insulations available for various temperature ranges. Nylon is generally used in the low temperature range, vinyl up to 150F, Teflon up to 500F, and silicone impregnated woven glass, flexible ceramics, and woven glass sleeving for the high temperature range. The selection of glass must be made with caution since the electrical insulation breakdown with temperature varies with the type of glass used.

The universally-temperature-compensated gage manufactured with an active gage element combined with a platinum temperature sensor in a glass-phenolic matrix provides compensation on any material, at a particular temperature, or minimum response over

...without bustin'!

Patented Euclid "Expandohm" edgewound resistors flex and stretch with current surge and temperature rise—yet never a breakdown or shorting.

Corrosion-resistant plated metal parts with wide-open construction—special alloy resistor ribbon—EXCLUSIVE EXPANSION JOINT—all combine to allow expansion and contraction of the core strip, and to withstand the most severe shock conditions without damage to the porcelain.

Capacities from 1 to 75 amperes, lengths from 9 to 24 inches in 3-inch increments, and either clamp type or brazed type terminals are available. Call your local representative or

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WHAT'S YOUR PROBLEM?

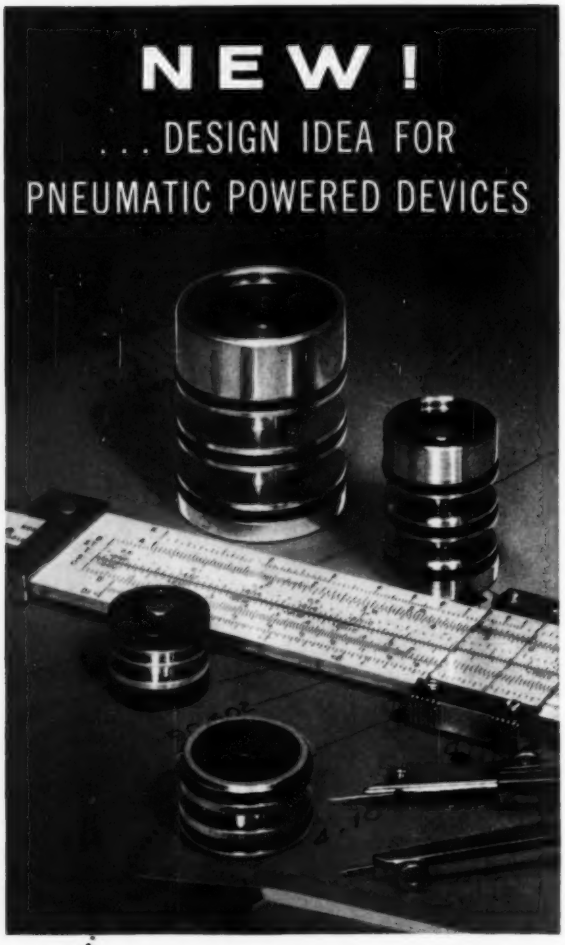
EX-20

The EUCLID Electric & Mfg. Co.

MADISON • OHIO




Circle 752 on Page 19

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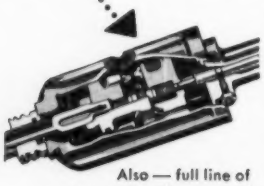
Choice of 2-way or 3-way, in ⅛" or ¼" sizes, for manual, electric or piloted operation. *Write for bulletin pictured below.*



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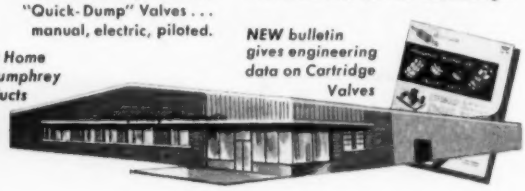


any temperature range between −320 and +500 F. The same gage type provided on a strippable backing material for transfer into ceramic cements may be used up to 850F. The versatility of this gage type is accomplished by adjustment of an external resistor placed in series with the "dummy" arm platinum sensor so that the normal temperature response of the active arm gage is cancelled.

A great deal of work is being directed toward the use of semiconductors as strain gages. Sensitivities of fifty to one hundred times that of a conventional constantan bonded wire gage have been achieved. Problems concerning strain range and temperature response must be solved before this gage type can be considered practical for the experimental stress analysis field.

While the application requirements for strain gages are varied and changing rapidly, a great majority of the problems can be solved by proper selection of the gage type to be used. Under ideal conditions of temperature where compensation for temperature response and drift is possible, static strain measurements to 1200F may be accomplished. Under less ideal operating conditions, a limit of 600F is more realistic. Dynamic strain measurements have been made successfully in the 1400 to 1500F range. In the very low temperature regions, strain gages may be used effectively without severe sacrifices in accuracy.

*From a paper entitled "Present Day State of the Strain Gage Art", Presented at the Seventh Annual Cleveland Electronics Conference, Cleveland, February,* 1960.

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## A PHILOSOPHY OF MATERIALS HANDLING

By J. E. WILTRAKIS
Assistant Superintendent
Factory Engineering
Western Electric Co. Inc.
Kearny, N. J.

AT TIMES in the last century we made great strides in facilitating the handling of materials. Men began to make materials flow more quickly and at less expense over greater distances. There developed an increased awareness of the advantages of standardization and the beginnings of systems studies and analyses. In certain periods of the century there was more attention given to the transportation or distribution of goods and the communication of data and information. At other times, such as the recent period, more of the research and development activities were devoted to the conversion of materials. By conversion I do not mean manufacturing. Manufacturing includes, even within a factory, both conversion and distribution of materials and information. By conversion we mean the physical change of the shape, form, and appearance of materials and the mental evolvement of new ideas. It even includes fusion and fission. We have learned to convert in seconds or micromicroseconds.

Most of the total cost within factories relates to the distribution of goods and services rather than to conversion. Also, if we contemplate the entire system of flow from mine or field to consumer, the distribution

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**FAST** Geneva motion smoothly positions in speeds up to ½ sec.

**RUGGED** 1000 lb. work load with solid anvil capacity of 30 tons.

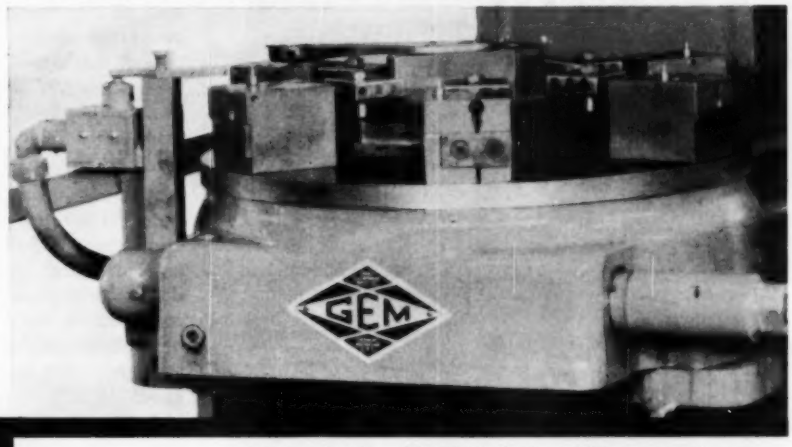
**POSITIVE LOCK** Bolt in Geneva slot cammed both in and out given positive locking.

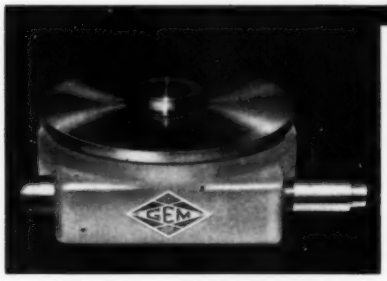
**POWER** Comes complete with rotary air motor, solenoid valve with limit switch (fluid or electric motors available).

**NUMBER OF STATIONS** 6, 8 or 12 standard, 3 and 4 skip.

**SIZE AND WEIGHT** 200 lbs. complete with 17" dia. table (plates up to 36" available).

GEM-17 mounted on GEM ATP-6, 6 ton toggle press with standard GEM base.




gem

**Geneva Motion GEM-17 Indexing Table** standardizes automation on your assembly and machining operation . . . drilling, tapping, riveting, spinning, staking, knurling, chamfering, welding, screwdriving, stud driving and gaging to the speed and accuracy required. Gray's complete engineering staff can adapt the table to your work problem.

*Send for Bulletin DI-17 and complete information.*

**GRAY equipment company**

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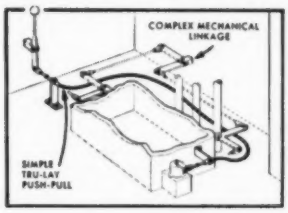
*Circle 754 on Page 19*

# TRU-LAY PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY AND IMPROVE DESIGN




Push-Pull remote controls, shown here, are flexible, have but one moving part, and give a lifetime of accuracy. Mechanical linkages are complex, are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.

This Push-Pull Data File—containing 7 engineering bulletins—will show you how these flexible controls have eliminated mechanical linkages on hundreds of products. You can make *your* products more useful, easier to sell, with Push-Pull controls. Write for your Data File today.

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*Circle 755 on Page 19*

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**CYLINDER BRUSHES and LIFEWOOD® WOOD BACKED BRUSHES**

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*Circle 756 on Page 19*

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**...feeds dollars into your profit column**

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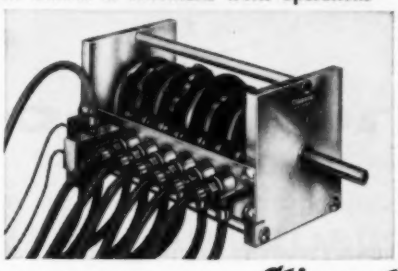
factor is the major portion of the price. By distribution we mean the system of activity covering ordering, purchasing, recording, inspecting, finding, handling, assembling, storing, transporting, packaging, shipping, and selling materials and services. These are all interrelated functions. Even in a library, laboratory, or office, the same relationships prevail. The movement and storage of materials and information, we believe, is a single problem. Materials handling and data processing are closely interrelated and have similar activities and solutions.

It is not difficult to hypothesize that nearly 80 per cent of the total U. S. annual gross national product of approximately $450 billion can be visualized as the price of distribution. We might question the causes for high distribution costs and the magnitude of the investment which must be provided as we rapidly change our conversion methods. What would more standardization and more systems visualization do to provide more goods of current and future designs, at lower cost, of higher quality, to more people? What can we do to attract the attention of our best brains to the relationships which are universal to all materials handling and data processing? Consider the advantages of making packaged units of components and assemblies in standardized sizes suitable for assembly, handling, and storage by standardized materials handling devices. Automation of materials and data flow can be facilitated. We have need for a study of our economy from a perspective which, as specialists, we cannot visualize. We need general practitioners in the field of materials handling and distribution who will provide healing solutions to a dynamic economy rapidly draining funds and capital. How much we could improve the well-being of our fellow man if we could only divert some small portion of the savings that could be made by improved distribution methods!

Line organization in many activities is slow and cumbersome—a rigid chain of command, populated by easily satisfied specialists and tied down by accepted routines, limits its accomplishments. Great progress could be made in these units if even a few individuals motivated themselves to use the systems approach, conceiving the whole area of their materials handling as being analogous to the continuous flow in progressive petroleum industries. Knowledgeable managements and engineers are becoming increasingly aware of the advantages of systems studies and the need for providing plants and distribution systems today for products not yet designed. They visualize the universal characteristics of materials and advantages of standardized equipment for the flow of materials. Breakthroughs in distribution are imminent. It is our hypothesis that 80 per cent of the total economy in the United States is the price of distribution and that by the study of data processing and materials handling lucrative savings can be uncovered. Because data processing and materials handling have the same elements, they should be studied as one system. Specialization clouds our vision; integration is what we must seek.

*From a paper entitled "Standardization and Materials Handling" presented at the Tenth National Conference on Standards of the American Standards Association, Detroit, October,* 1959.

**NEW** STURDY, PNEUMATIC — ELECTRICAL
**SEQUENCE PROGRAMER**
for Precise Control of Automatic Work Operations



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Reasonably PRICED . . .
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Now — a rugged, dependable, inexpensive pneumatic-electrical sequence programing unit for precise control of your automatic tooling and work operations! Overall size 7⅛" x 3⅜" x 4". End plates tapped for mounting bottom or rear. Self-lubricating bearings. ⅜" steel shaft may be extended out either or both ends for tandem operation. Selection of any combination of 8 standard long-life, easily machined single piece phenolic cams fills majority of requirements. Special cams available at nominal cost. For millions MORE cycles of trouble-free service life and simplest maintenance, use with Clippard MINIMATIC VALVES and CAM FOLLOWERS as shown above.

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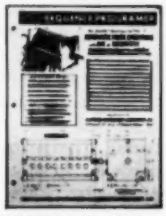

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*Manufacturers of Precision Pneumatic Devices, R. F. Coils, Electronic Equipment*


*Circle 758 on Page 19*


**DEEP HOLE DRILLING**
*Single or Multiple Spindle*

Available in from 1 to 5 H.P. —up to 12" Stroke

* **STEP AND REPEAT ACTION—*NO SHOCK***
The number of steps possible is infinitely variable —to satisfy any requirement.
* Reduces breakage and over-heating of drills.
* Can be added to existing machine, or used to replace old style units.
* Adaptable to any single or multiple —spindle application.
* Self contained—Compact

Write for Literature

Typical example of a multiple spindle unit drilling in medium hard cast iron.

| A Drillunit—5 H.P. Capacity will drive |
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| 10 ¼" dia. drills |
| or 6 ⅜" dia. drills |
| or 4 ½" dia. drills |
| or 3 ⅝" dia. drills |
| or 2 ¾" dia. drills |
| or 1 1" dia. drill |

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HYDRAULIC DRILL UNITS
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*Circle 760 on Page 19*


**NEW JUNIOR SIZE VIBRA-WASHER**
*GIVES YOU AUTOMATIC PROCESSING OF METAL PARTS*

The new Simplicity Junior Size Vibra-Washer employs a vibrating work carrier that automatically conveys metal parts through a cleaning or conditioning bath. It cleans so thoroughly that chips, oil and grease are removed from even blind or slotted openings; cleans so gently even the most delicate threads or flanges are not harmed.

If you have a tough cleaning or conditioning job, Simplicity Engineering Company can help. For information, write or call the Industrial Washer Division.

223

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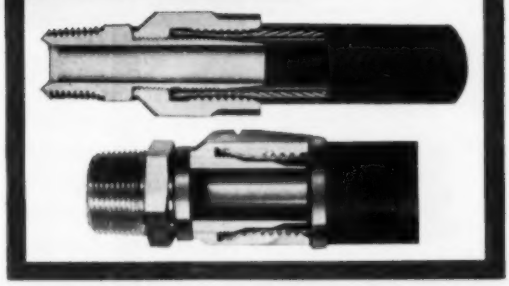
*Circle 759 on Page 19*


**Reusable Couplings** for Cotton Cover—1 and 2 Wire Rubber Cover Hose



Cutaway views show how EASTMAN Two-Piece Couplings are engineered to permit full flow through maximum orifice. Hose is molded into precision-machined recesses for firmer grip and longer life.

Down-time and operation costs in the field are greatly reduced by using EASTMAN Reusable Couplings for your Original Equipment. Standard hex sizes permit easy application without special tools.

Designed for use with oil, grease, air, water, hydraulic fluids, liquefied petroleum gas, anhydrous ammonia, refrigerant gas, and gasoline.

**REUSABLE HOSE ASSEMBLIES ARE IDEAL FOR EXPERIMENTAL MODELS**

WRITE for Technical Bulletin 100 for all sizes and styles.

**Eastman** MANUFACTURING COMPANY
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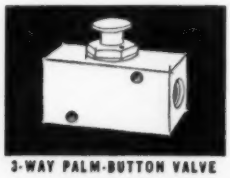

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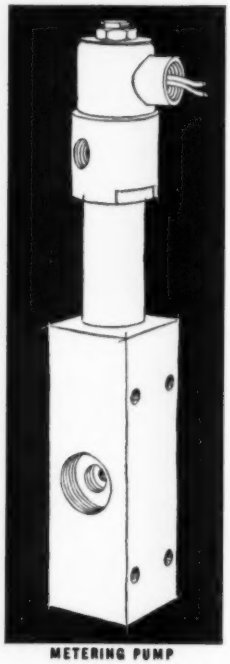
FOR DEPENDABLE AIR CONTROL ASK FOR



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AUTOMATION

# new books

### NONDESTRUCTIVE TESTING HANDBOOK, VOL. 1 & 2

*Edited by Robert C. McMaster, professor of welding engineering, Ohio State University;* 1850 *pages,* 6 *by* 9 *inches, published by Ronald Press Co., New York; available from* AUTOMATION; $24.00 *postpaid.*

Developed under the auspices of the Society for Nondestructive Testing, this set of handbooks is a significant contribution to technical literature. All aspects of nondestructive testing are covered and a sizable part of the handbooks is devoted to newer techniques, such as immersion ultrasonic testing, isotope radiography, and eddy current testing. Of particular interest is a section covering Eddy Current Test Automation. The set is well illustrated with charts, graphs, tables, and photographs and represents the efforts of 106 contributing and consulting authors.

### FLUID POWER CONTROL

*Edited by J. F. Blackburn, research associate Massachusetts Institute of Technology; Gerhard Reethof, supervisor control system design, Jet Engine Dept., General Electric Co., and J. L. Shearer, associate professor, Massachusetts Institute of Technology;* 710 *pages,* 6 *by* 9 *inches, published jointly by John Wiley & Sons Inc., New York, and the Technology Press of M.I.T.; available from* AUTOMATION; $17.50 *postpaid.*

Eleven authors, as staff members of the Dynamic Analysis and Control Laboratory of M.I.T., contributed to this work. The book deals with the use of fluids at elevated pressures in the transmission of power. Rather than describing hydraulic and pneumatic components, it covers the principles of operation, design, and application of fluid power devices and techniques. Fundamental considerations are supplemented by discussions of present practices in the fluid power field.

### AUTOMATION TODAY AND TOMORROW

*By L. L. Goodman, industrial specialist, British Electrical Development Association;* 275 *pages,* 5½ *by* 8½ *inches, published by Essential Books, Fair Lawn, N. J.;* $7.20.

More of a summary report than a text, this offering is divided into two major parts. The first 117 pages contain brief descriptions of a variety of functional areas as influenced by automation and descriptions of developments in specific industries. The remainder of the book is devoted to an indexed bibliography of articles, papers, etc. covering various aspects of automation.

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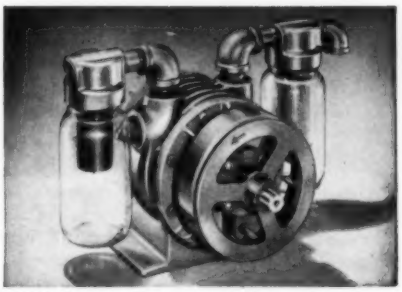
PRODUCTS

**Runs without oil —**

Model 3040 Oil-less Air Pump. Vac. to 20", pressure to 10 p.s.i. To 24 c.f.m., ¾ to 1½ h.p.



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# GAST AIR PUMPS

**Other Oil-less Models**

Built in six smaller sizes, some with integral motors — 1/12 to ⅓ h.p.

See Catalog in Sweet's Design File

Need compressed air that's *absolutely free* of oil mist? A Gast Oil-less Air Pump may be your answer! Air flow *can't* contain oil vapor, because no oil is used.

You also eliminate lubrication problems when vacuum or pressure pump is mounted in a hard-to-service location.

Four carbon vanes lubricate themselves. Ball bearings are grease-sealed for life and separated from pump chamber by a ventilated space. Built in 7 models.

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GAST ROTARY
- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

*"Air may be your answer!"*

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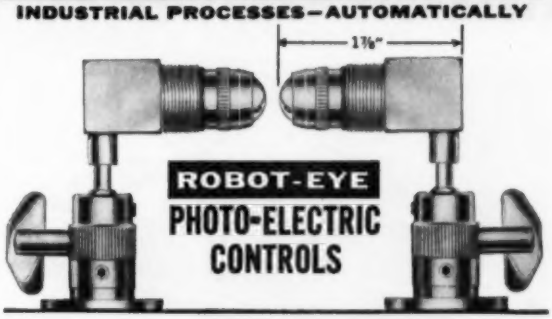
# count, inspect, control
**INDUSTRIAL PROCESSES—AUTOMATICALLY**

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Small, for "tight-spot" installation, yet rugged for long service. Accurate, for precise automatic control in virtually any industry.

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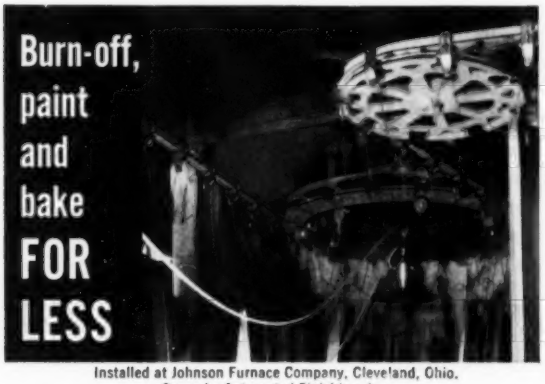


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Ovens by Automated Finishing, Inc.

# AMERICAN "CABLE-WAY"
## costs less per conveyor-foot

This customer-installed American "Cable-Way" conveyor carries warm-air furnace parts thru a 600° burn-off oven, an electrostatic spray, a 325° bake oven, and finally to assembly bays. Total length, 1200 feet.

Rugged, yet lower in cost due to all-bolted 2" x 2" x ¼" inverted T-rail and lightweight cable. Trolleys can be selected to fit the load, from 80, 125, 160 or 250 lb. capacities. Write for Catalog CD-B.

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**CONVEYOR DIVISION**
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## FOR CONTINUOUS.....
# HI-SPEED
## SMALL-HOLE PRODUCTION

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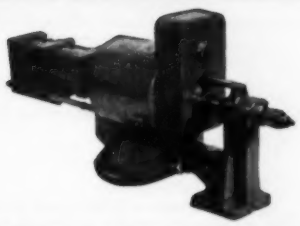

| MODEL 111—3/32" CAPACITY | MODEL 113—1/4" CAPACITY | MODEL 603—1/2" CAPACITY |
|---|---|---|
| 1000 to 10000 RPM or 2500 to 15000 RPM CONTINUOUSLY VARIABLE SPEED CONTROL | 15 SPEEDS TO 15,000 RPM | 600 to 4000 RPM WITH VARIABLE SHEAVES |

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**FREE Descriptive Bulletin**

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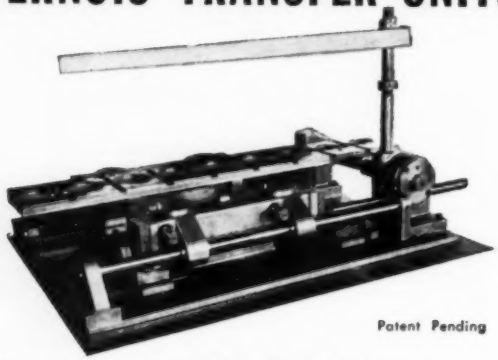
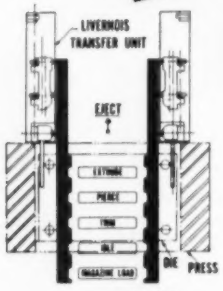
Get Efficient Automation with

**LIVERNOIS TRANSFER UNITS**



Patent Pending




**HERE'S WHAT THE LIVERNOIS TRANSFER UNIT WILL DO FOR YOU:**

- Lower Die Costs
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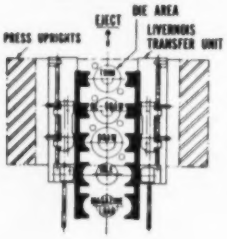
- Less Maintenance
- Save on Material
- Increases Production—with fewer presses

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The Livernois Transfer Unit is a completely mechanical device without any electrical, pneumatic or hydraulic aids. Automation is attained entirely by movement of the rams.

Ideal for machining application such as drilling, tapping, chamfering and deburring by actuating unit with air or hydraulics.

Ten different models and sizes. Engineered to fit any press. Can be used from press to press, from year to year. Readily and quickly adjusted for transfer distance and finger in and out movement.

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### MODERN ELECTRONIC COMPONENTS

*By G. W. A. Dummer, head of components research, development, and testing, Royal Radar Establishment, Ministry of Supply (Great Britain); 472 pages, 5½ by 8½ inches, published by Philosophical Library Inc., New York; available from* AUTOMATION; $15.00 *postpaid.*

The author has undertaken to summarize essential data on commonly used electronic components. Among the items discussed are: Resistors, capacitors, wire and cable, plugs and sockets, relays, switches, transformers, batteries, and miniature components. A separate chapter is devoted to components for use with printed wiring and automatic assembly systems. The book undoubtedly fulfills the author's aim of providing a single source that will aid a user in understanding basic characteristics of electronic components.

### ELECTROMAGNETIC FIELDS, ENERGY, AND FORCES

*By R. M. Fano, professor of electrical communications; L. J. Chu, professor of electrical engineering; and R. B. Adler, professor of electrical engineering, Massachusetts Institute of Technology; 520 pages, 5¼ by 9 inches, published by John Wiley & Sons Inc., New York; available from* AUTOMATION; $12.00 *postpaid.*

This book is part of a series prepared by the faculty of the Department of Electrical Engineering at M.I.T. and known collectively as the "core curriculum". The series is concerned with developing the foundations of a modern electrical engineering course. This text is devoted to development of a consistent macroscopic theory of electromagnetism and discussion of the relation between circuit theory and field theory.

### PRODUCTION CONTROL

*By Franklin G. Moore, professor of industrial management, University of Michigan; second edition, 655 pages, 6 by 9 inches, published by McGraw-Hill Book Co. Inc., New York; available from* AUTOMATION; $8.00 *postpaid.*

This rewritten and expanded edition reflects the rapid changes that have taken place in the area of production control. The author identifies a continuing trend toward tighter control and more quantitative control over operations. In the light of this trend, the chapters concerned wih forecasting, planning, operations research, and the use of tabulators and computers are of special interest.

## Association Publication

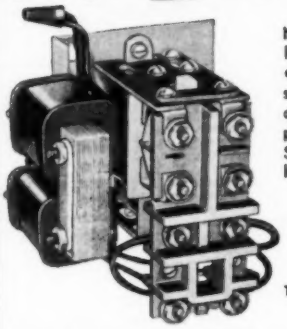
### VALUE ENGINEERING—1959

*Available from Engineering Publishers, P. O. Box 2, Elizabeth, N. J.; 165 pages, 6¼ by 9¼ inches, illustrated;* $6.00.

This hard cover book contains reprints of technical papers presented at the Electronic Industries Association Conference on Value Engineering held at the University of Pennsylvania during the fall of 1959. The papers covered such topics as basic concepts and philosophies, techniques, application, and the relationship of value engineering to other disciplines.

# WARRICK Floatless Electrode Type LIQUID LEVEL CONTROLS . . .

## give you all these advantages!



No moving parts in the liquid • Easy to install • No adjustments necessary • Unaffected by acids or caustics • Unaffected by pressure or temperature • Standard 2&3 pole units listed by U/L

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Two pole control shown at left

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- Single & multiple pumps
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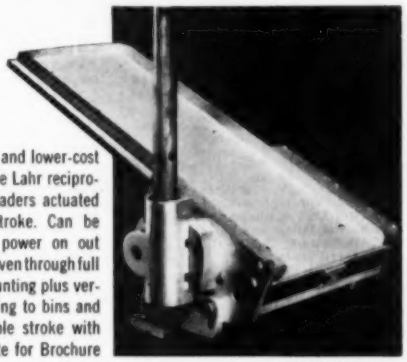
# NEW PART UNLOADERS REDUCE HANDLING



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Model 20-59 shown

**STANDARD MODELS AVAILABLE**

| Model No. | Tray Width | Tray Stroke | Power In | Power Out |
|---|---|---|---|---|
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| 20-CT-59 | 10" to 36" | 10" to 30" | Cable | AirCycle |
| 30-RR-59 | 10" to 72" | 12" to 30" | Rack | Rack |
| 30-CT-59 | 10" to 72" | 12" to 30" | Cable | AirCycle |

Special tray widths and strokes available

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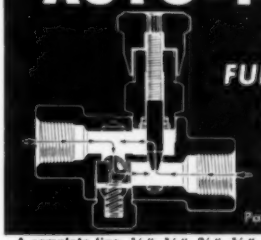

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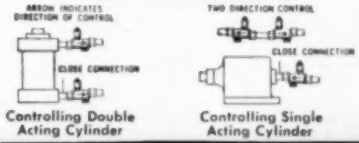


Controlling Double Acting Cylinder

Controlling Single Acting Cylinder

AUTO-PONENTS INC. 2939 GRANT STREET BELLWOOD (Chicago Suburb) ILLINOIS

Circle 770 on Page 19

# CUMULATIVE EDITORIAL INDEX

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*AUTOMATION is indexed in the Applied Science & Technology Index and the Engineering Index, available in libraries generally.*
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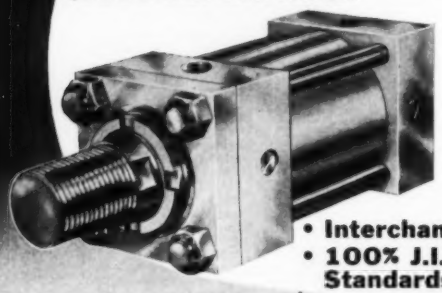
SP HIGH-PRESSURE HYDRAULIC CYLINDERS

2000 PSI
(3000 PSI non-shock)



• Interchangeable
• 100% J.I.C. Standards

12 Bore Sizes: Compact 1⅛" thru 12"

Quick-Change Front Removal Cartridge
Self-contained unit externally removable, no need to loosen tie rods or dismantle the cylinder.

"Clinch-Tite" End Seal
Maintains leakproof seal at all pressures, ends "O" ring extrusion at pilot fit.

Interchangeable Cushion Check and Adjustment
For maximum flexibility; space-saving flush design; easy to adjust.

Heli-Coil® Piston Lock
Easy rod service with no loss of thread strength; meets rigid aircraft standards.

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For *intensified* hydraulic pressure that you can control for punching, riveting, clamping, pressing, shearing, crimping—add an S-P Air-Oil Booster to your air line—no maintenance, no pumps, no valves; saves space, uses line air to hold intensified pressure as long as desired. Write for Catalog 116.

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are you stuck?

# confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

CASE 2016-P

## CURRENT CONTROL

. . . For a proposed automatic graphitizing furnace, we are interested in controlling currents of magnitudes between 1,000 and 10,000 amperes. We are in possession of an induction voltage regulator in which load voltage is controllable by changing the angular position of the secondary with respect to the primary. A reversible motor in the voltage regulator is now manually operated to position the secondary for current control through the load. We need a current sensing element and on-off controller which can be used to automatically actuate the reversible motor in the voltage regulator in obtaining current control. Bus bars carry the secondary current, therefore the primary is probably the recommended location for the sensing element . . .

**Project Engineer**

CASE 2019-P

## POSITIONING DEVICE

. . . For some time I have been considering the application of a two dimensional positioning device that would need a range of approximately 30 by 80 inches. Accuracy of positioning required would not be greater than plus or minus 1/32 inch for each axis. The load to be started and stopped would probably not exceed 50 pounds . . .

**Plant Manager**

CASE 2018-P

## LEAK DETECTION

. . . We have a small finned-tube assembly which we presently leak test by applying air at 15 psi and immersing the assembly in water. This type of testing necessitates a subsequent drying operation. We would like to improve the testing both as to rate of production and elimination of the drying operation. To this end we are looking for either a vacuum or pressure type of automatic testing compatible with production rates of 300 or more units per hour, and as sensitive as the water test. Preferably the testing equipment would indicate by means of a light or sound device when a unit was not leak tight . . .

**Chief Manufacturing Engineer**

CASE 2020-P

## AUTOMATIC SOLDERING

. . . I am interested in obtaining information on equipment or processes available for automatic soldering of small fusible links. We manufacture a line of fusible links and would like to automate this process if equipment or methods have been developed . . .

**Plant Engineer**

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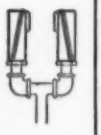
Remote Heads for Small Space

E8A-E8AP Remote heads with special mounting bracket



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**Heavy Duty Industrial Construction.**

for tension, jam-up, counting, registration, illumination, liquid and material level — sorting, measuring, weighing, inspection, die-protection, smoke detection, packaging, processing, marking.

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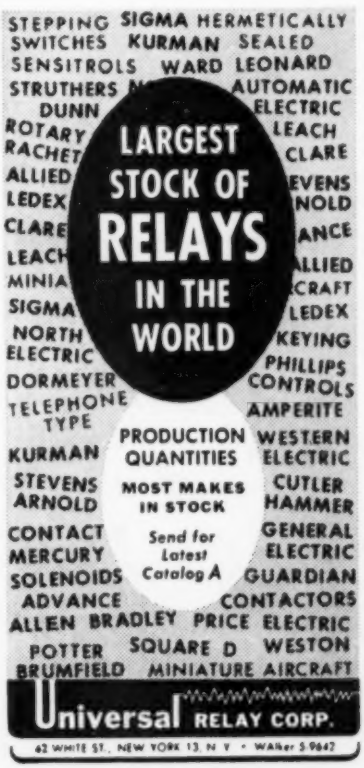


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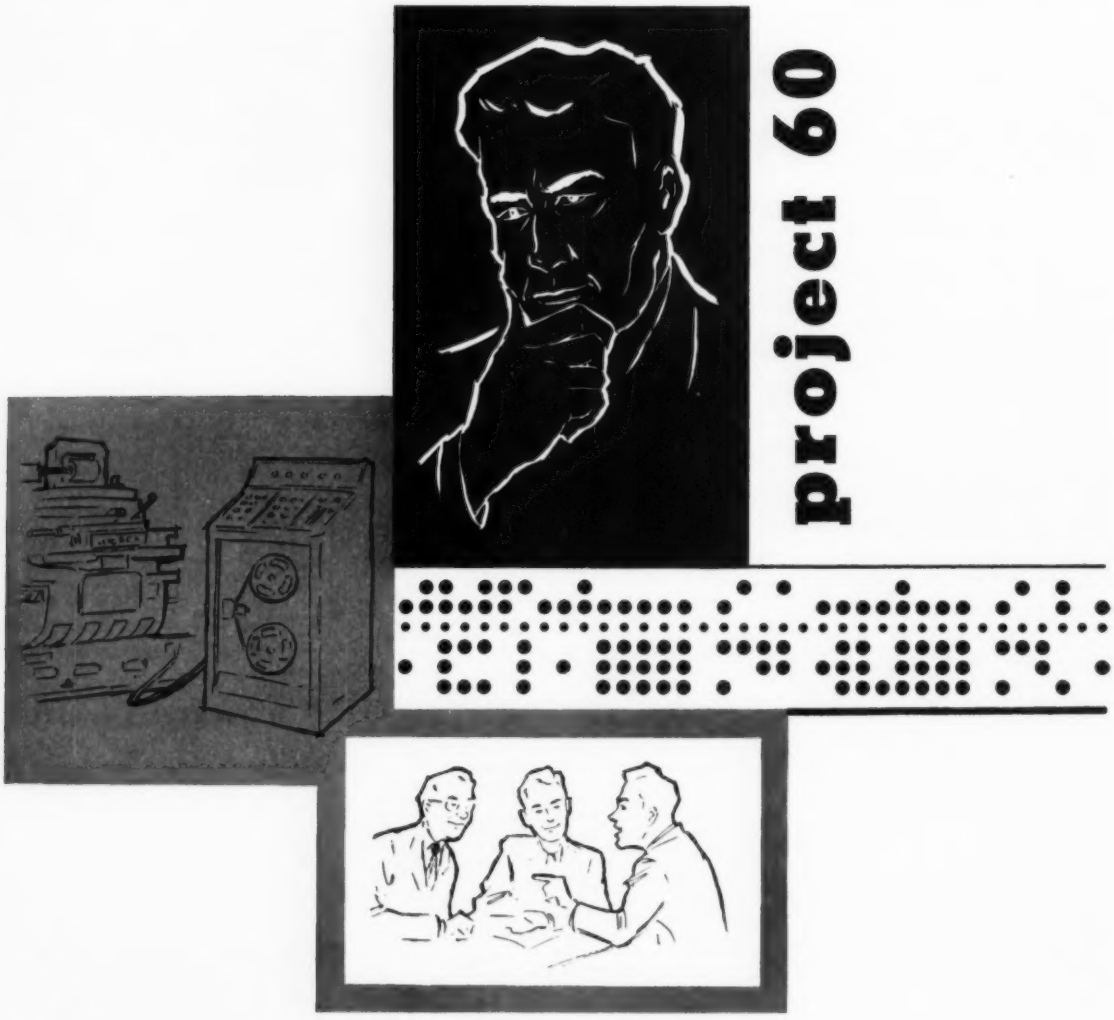


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PROJECT 60 will present industry's latest developments in numerically controlled machines. This exciting editorial section will appear in the August issue of AUTOMATION. It will keynote the 1960 Machine Tool Exposition and Production Engineering Show to be held in Chicago, September 6-16.

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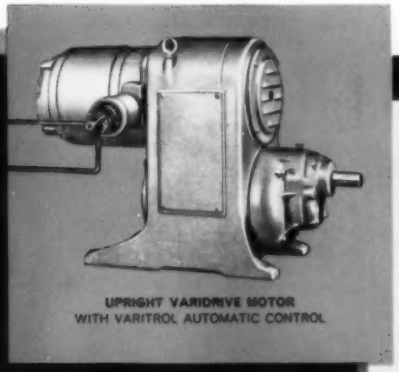

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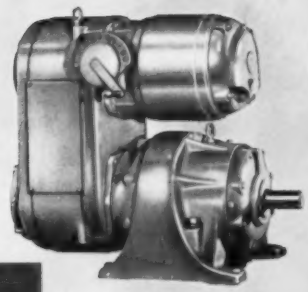
WITH VARITROL AUTOMATIC CONTROL



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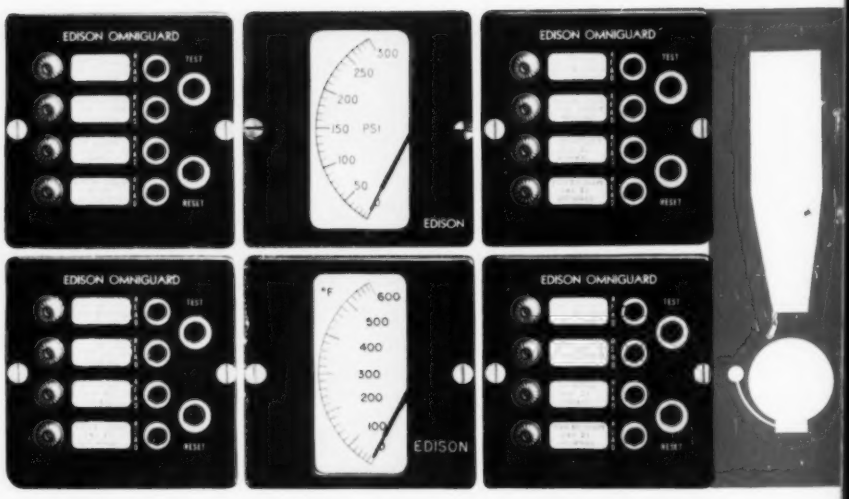
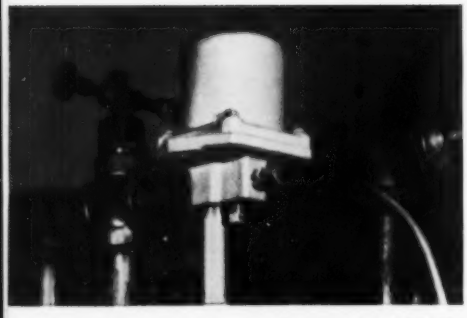



Here is a versatile, highly-reliable continuous warning and monitoring system. By simply pushing a button on this panel you obtain a reading of *key pressure* and *temperature* points throughout your plant. In addition, this system provides instantaneous warning when pressure or temperature deviates from pre-set limits.

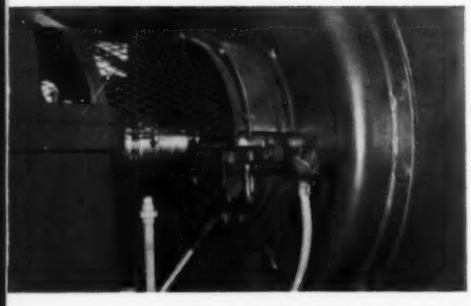


*Compact, reliable Resistance Pressure Detector transmits changes in pressure to central control panel.*

## PRESSURE

With the Edison Omniguard system you can monitor gas, fluid or vapor pressure. Heart of the system is a rugged, accurate, pressure detector which converts pressure directly to electrical resistance—requires no millivolt conversion—no amplifier. For pressures under 60 PSI a precision capsule is the sensing element. From 60 to 3000 PSI special bourdon tube elements are used.

When pressure changes, resistance varies and this deviation is transmitted to the control panel. Units operate over ambient temperatures of 32° to 150°F. Control panels are available with a wide variety of scales and are equipped with both normally open and normally closed alarm contacts to operate any type of auxiliary device or to automatically shut down machinery or process.



*Rugged, accurate Resistance Temperature Detector guards against overheating of this motor bearing.*

## TEMPERATURE

Edison Omniguard also provides reliable protection from overheating. You can monitor the temperature of bearings, gases and liquids in critical equipments or processes. Reliable Edison Resistance Temperature Detectors have no moving parts and give instantaneous warning when limits are exceeded. Unlike other systems which only scan, Omniguard is continuously monitoring. You can obtain exact readings of temperatures in all parts of your plant from one central control panel.

For greater flexibility and reliability each detector circuit is completely independent. If one circuit is damaged, all other circuits remain "on guard." When changes or additions are required they can be accomplished quickly and easily.

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